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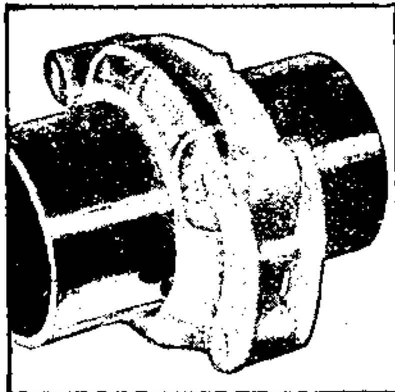

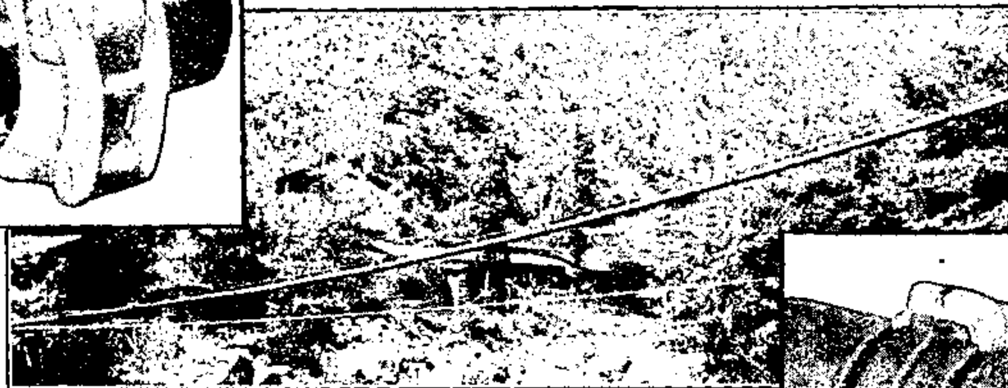

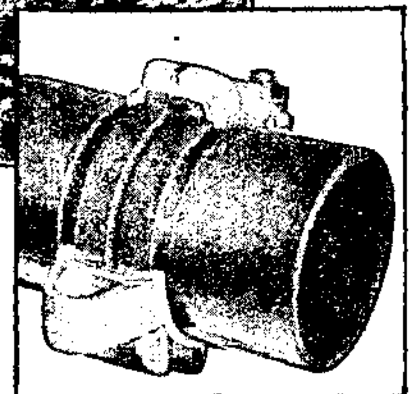

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SMALL CHANGE FROM DUNKIRK.

By MAJOR M. C. A. HENNIKER, M.C., R.E.

(*Reprinted from "Blackwood's Magazine," November, 1940, by kind permission of Messrs. Wm. Blackwood and Sons, Ltd.*)

A FRENCH officer, a friend of mine, once said to me: "The trouble about the British Army is, it always runs away." I remonstrated against this, and he explained: "Look," he said; "Sir John Moore retired to Corunna, the Duke of Wellington retired to the lines of Torres Vedras, the Old Contemptibles retired from Mons in 1914, and the 5th Army retired in 1918." "But," I said, "in 1914 at Mons and in 1918 the French also retired." "Yes," he replied, "but we do not talk or write about those events and you English never stop"; and that is my excuse for writing now about the retirement to Dunkirk. What we saw in a Field Company was only a worm's-eye view of the whole operation; we had no conception of the large strategic plan. Our lot was but the small change in a giant gamble—a gamble that "came off."

As far as we were concerned the retirement started about dinner-time on 26th May, when the Colonel called for the Company Commanders and said that it had been decided to extricate the B.E.F. from France by hook or by crook. By this was implied the officers, N.C.O's, and men, with such equipment as they could carry on their backs, but nothing else. I went back to the company and explained this to the officers and to the serjeant-major, and the company was on the move in a little more than an hour.

We laboured in the dark along unsigned roads with indifferent maps among places peopled by the ghosts of the armies of 1914–18: Plugstreet Wood, Neuve Eglise, Poperinghe, and so towards the north.

As the dawn broke we were near Neuve Eglise, and there we first saw signs of general retreat. Three lines of traffic, sometimes four, down the road, French artillery dragged by horses, refugees pushing prams, riding on carts and on foot, motor lorries streaming towards the sea, and the indefatigable gunners bringing up the ammunition in the other direction to feed their guns. Of course, there were checks and delays, and each delay made one extremely anxious, because there was always the haunting fear of German airmen coming overhead to machine-gun or bomb us. This, in fact, did happen at Neuve Eglise. Horses stampeded, women and children

yelled, two lorries in front of us burst into flames, everybody jumped out of his vehicle and into a ditch. But by some miraculous chance not a single man or vehicle of our company was damaged in any way. From then onwards the tempo of the battle quickened in a gradual crescendo.

We sent out detachments to blow up the bridges over the canals, and we moved the headquarters of the company to a little village north of Poperinghe. I do not remember the name of the village, and I do not want to; for it was one of the most melancholy that it is possible to imagine. The sky was overcast, and the tall church and long steeple were silhouetted against the leaden clouds. A Red Cross flag hung from the steeple, and ambulances, lined up in queues, discharged their contents into a hospital near-by. Soon it started to rain. It poured down with tremendous vigour, and the sound of thunder was added to the din of the battle. A private soldier with a motor-car came up to me and asked what he should do; his officer was a casualty in the hospital and he had all his kit in the car. I went to see the officer to tell him that I thought the driver should be attached to us and that I would look after him; but the officer was delirious and said only that he hoped the driver would wait with his kit until he could go back to the battery. Information then came in that more bridges were to be demolished, and we sent detachments with explosives to carry out the work.

This left me alone with the company headquarters section, with nothing in particular to do. I could not go away, as I might be wanted. In parenthesis it must be said that for the nerves there is nothing worse than having nothing to do but watch columns of men and vehicles passing by from front to rear. Everyone who passes tells you the Germans are just round the corner. I put on my belt and pistol with the rather melodramatic intention of being captured dead rather than alive, and strolled round the village. There was a fatigue party digging—air raid trenches presumably. I leant against a gate wondering why they chose such a stupid place for trenches, when a procession came round the corner headed by a parson—a column of men with stretchers, each with a Union Jack on it. The parson said the prayers, the cortège departed, and the gravediggers made the kind of obscene jokes that gravediggers do.

I went back to my headquarters and had some food. Two gunner subalterns, one of them wounded, staggering along the road, came to a halt by the doorway where I was standing. I offered them some food, and one of them said that the other had personally manned an anti-tank gun and destroyed two enemy tanks within two miles of where we then were. This may not have been absolutely true, but it did not add to one's peace of mind, and by four o'clock on the following morning—that is, 28th May—I decided to move the company to a small farmhouse half a mile away, where this dismal

process of retirement was not in view of all the men. We made them wash and shave and gave them breakfast, and this had a very salutary moral effect on all of us; moreover, about this time we also received orders to prepare some more bridges for demolition. As soon as inaction had ceased and the violent turmoil of movement started again, all the depressing thoughts of last night were cast away, and we went to our new job almost with light hearts.

I moved the company, according to orders, to a nice, clean, little village lying on the edge of the marshes, surrounded by the complicated waterways and canals of Northern Belgium, and went to see the demolitions that we had been preparing during the last six hours. Two of them had already been prepared by the Belgians, and appeared to be very satisfactory. Firing parties were put on each bridge, and it seemed that we should have a night's sleep. But this was not to be; for, owing to the heavy casualties of the infantry, we had to take over a piece of the line, patrolling along the canal bank between two of the bridges that we had prepared for demolition. However, in this particular sector, the enemy was as tired as we were and gave us no trouble, so that we had a quiet night and many of us got some sleep.

Next morning the news of the Belgian capitulation reached us on the French wireless. It was difficult to tell whether we had misunderstood the French or whether it was really true, and the awful thought occurred to me that perhaps the explosives for these demolitions had been prepared by the Belgian engineers, knowing full well that they did not intend to fight, and that therefore they had not charged the chambers with dynamite but with sand—a sort of face-saving demolition. There was nothing that could be done about it: the bridges had to be demolished by ten o'clock in the morning, and it was already too late to substitute our own explosives. Just before ten o'clock the last of our infantry was across the bridge, and we pressed down the handle of the exploder. I can hardly explain my relief when I heard a deafening crash, and, through a slit in the brick wall behind which we were hiding, I saw the bridge fly into a thousand pieces and disintegrate into a cloud of smoke and dust. At this moment the Belgian engineer who had prepared the bridge for demolition came up to me and said, "At any rate, the last job I did before my army surrendered was well and truly done." I must say that there appeared to be quite a number of Belgians who were extremely ashamed of the part their country had played in the battle. Many of them in fact, came to our units saying they wished to fight for the allies, and would we enrol them.

Just after this we received orders to prepare some more bridges for demolition in a sector behind one held by the French. We set to work, and a French general walked up with the easy nonchalance

of a gentleman out for a walk before breakfast. He seemed delighted to find that we were helping, and detailed one of his officers to form a liaison between us and the French troops. This Frenchman was as tough an egg as it is possible to imagine ; he was small and squat, with a square face, a flattened nose, and a prominent jaw with two days' growth of beard. He told us he had been wounded twice fighting the Riffs in Africa, and that he reckoned the Bosche was not such a very remarkable fellow.

Hour after hour elapsed before the French were ready for those bridges to be demolished. As the afternoon wore on the German artillery started to shell them. The French said they must not be demolished until the German advanced units actually appeared on the other side, but it became increasingly obvious that the splinters of the shells bursting round about might easily cut the leads to the charges and so prevent the bridge from being blown up. For a bridge to fall undamaged into the hands of the enemy would be, of course, a disastrous failure ; for then our infantry would have no respite from the harassing fire of the enemy's armoured cars and tanks, which would be hurried across the bridge. I therefore decided to order the bridge to be demolished whether the French liked it or not. When it was done the French liaison officer said to me, " I only wanted to wait for the enemy to come, so that you would not think me afraid in firing the bridge early and running away."

For some reason or other, which I now forget, we were all under the impression at this stage that we should forgather at the church in Furnes. I cannot remember who gave this order or how we came to have this impression. The fact remains that at about four o'clock in the afternoon of the 29th May the whole company with its transport was assembled in the churchyard, and the German artillery elected this very minute to shell the town. Of course the church, with its high ornamental towers, formed a prominent object on which to train their guns. We all cowered in rather a futile way under the buttress of the church, and we all wished we were in the crypt, but the door was locked. It was clearly ridiculous to remain there longer, so one by one we started the lorries and drove them as fast as possible out through the churchyard gates and into a wide road leading towards La Panne. The men stood down in the gutters until all the company was assembled, strung out along the road, and an officer led the column to some fields outside. There we received orders to stop for the night and to prepare defensive works on a canal between us and the enemy.

The only safe place seemed to be in the ditch. The enemy was both bombing and shelling the road, and occasionally a flight of German aeroplanes came and machine-gunned it. We therefore drove the lorries into the fields on one side of the road, with instructions to

halt higgledy-piggledy all over them. We took off the canopies of the lorries and ordered the troops to dig a hole three feet deep under the canopy of each lorry, thereby making a kind of igloo. In these igloos one felt extremely safe—and it is almost more important to feel safe than to be safe.

We cooked supper, and were just about to set out to improve the defences, working all night, when we received orders to go on foot for a very pressing duty at the shortest possible notice. No equipment was to be taken beyond what the men could carry on their backs. We, some of us, thought that this meant embarking in ships and getting away, and it was with light hearts that we walked down the road, one file on either side, towards where we knew the sea to be. After marching two or three miles we met a guide, who turned us off the road at right angles. In front of us we could see the flashes of the guns and hear the rattle of machine-gun fire. Shells burst from time to time on either side of the road. Any hopes we had of embarking were soon shattered by the adjutant, who came up to me and said: "Rather a crisis has occurred; the enemy is breaking through near the shore, and unless he can be stopped there is not the slightest chance of anyone getting away from this place. Field Companies are going to be put into this gap, as there is no one else to put." We therefore marched in silence along dark by-roads following our guide until we came to a farmhouse, which turned out to be the headquarters of the infantry battalion which had borne the brunt of the battle during the previous day and night. They had had heavy casualties, they were all exhausted, and they had very little ammunition left.

Taking over a position from another unit is never easy, especially when done in the dark by troops who have never had to do it before and who have had little or no experience of infantry work. It seemed unbelievable that we could ever get into the right places before dawn, when the enemy would discover that a change was taking place and know it was a suitable opportunity to attack. However, it somehow was achieved, and when the dawn broke our men had occupied the positions vacated by the infantry, and were digging themselves into the ditches as fast as they possibly could. The Germans were evidently as tired as we were. This is a thing all soldiers should remember: that the enemy generally is as tired as you are, and it is when they are tired that if you make a big effort you will defeat them. They may not have the strength of mind to make the big effort.

The day passed perfectly quietly, with bright sun and occasional fleeting clouds. It was ideal weather for air action, and we saw on our right front, during the afternoon, the most terrific bombardment accompanied by aeroplane bombing and machine-gunning. I felt that a bulge was being made in our line to our right front, and that if

we could do something about it quickly we might be able to squeeze it out by attacking in the right place. I therefore went forward to try to discover where the edge of the bulge was. We very soon realized that we were completely hemmed in by the artillery barrage, and that there was absolutely nothing we could do but lie in a ditch and hope for the best. Various kinds of shells were fired at us: mortars, 115-millimetre field-guns, and later the German anti-tank guns. The sappers in the line seemed completely unmoved by this, and the bulge that I thought was occurring was, in fact, pure imagination; for our men were all in position, cowering in their trenches while the shells burst harmlessly round them. When the barrage ceased, the troops just popped up in their trenches, and the enemy was no better off than before. This struck me as the most noticeable example of the proper behaviour of troops when shelled. You just lie low while the shelling goes on: the enemy infantry cannot get at you any more than you can get at them. When the shelling ceases you can pop up and shoot anybody who tries to attack you. The whole thing is not to be demoralized by the sound of the barrage, and to be able to get up and shoot with a steady hand as soon as it is finished. I went back to the company very much relieved, and felt that I learned a useful lesson which I passed on to the troops. Next day we profited from this same lesson.

The following morning, 31st May, the enemy attacked on our front. It was a lovely day with perfect visibility, and for some reason or other nearly all the shells that were fired at us were duds. We could see the German infantry running about in front of us, and, as one of the men remarked, they looked just like ostriches in the Zoo. The German infantryman wears a heavy pack on his back, which makes it necessary for him to lean forward as he runs, and the shape of his steel helmet, his leaning body, and the big pack on his back give him an appearance very like an ostrich.

Towards the afternoon we were ordered to make a counter-attack where the enemy had, we thought, broken into our lines. The whole thing struck me as truly absurd. I felt relieved, when it was successfully finished, that we had very few casualties. It always seemed that when the Germans attacked or counter-attacked they were invariably able to do so with every assistance. They had but to ask and they were supported by artillery, by aeroplanes, bombs, and machine-guns, whereas here were we attacking with two Bren guns and a handful of men with rifles and bayonets. I think the enemy must have been so astounded at this prehistoric behaviour on our part that he ran away to tell the joke to somebody else.

Later in the afternoon we received orders to thin out the line, starting at 10.30 p.m., and to get the men back to the beaches for embarkation. This all went according to plan and without the

slightest interference from the enemy. We came out of our trenches and moved slowly back to an assembly area, and from thence along the road that we had previously reconnoitred. The night was pitch black with low misty clouds. As we walked along the road we could hear the sound of shells bursting in the vicinity of the beaches. The roar of gun-fire became louder as we approached—there was firing from the enemy and our own artillery, and there was firing from the ships; it seemed that we were going to get a very hot welcome one way or another. We walked down the road with the men spread out on either side in single file. The village of La Panne was getting hell from the enemy, and a shell burst in the middle of the road in the leading section of the company. Whether we were knocked down by the explosion, or whether we fell down in sheer fright, I do not know; but the fact remains that we fell down in time, and only one man was hurt seriously and another slightly wounded.

As we walked through the town several houses were on fire, and shells were crashing in all directions; but we soon noticed that the enemy preferred to shell in concentrations on cross-roads rather than strung out along the road we followed. Mainly by luck we got across each cross-road while no shelling was taking place. As we were approaching the beach a staff officer came up and said: "Just where this road joins the beach the enemy is shelling like the devil." Whether he was nervous or just breathless I do not know, but he certainly was very agitated, and his advice to keep clear of the point in question was well worth taking, so we turned left through a thick blackthorn hedge and got out on to the dunes. Here we staggered along like a lost legion, through the soft sand up and down the dunes.

It was very difficult to keep direction, and we constantly had to halt to collect the stragglers and to take our bearings. It was certainly perfectly safe; for the chances of a shell pitching in the particular hollow that we were in was extremely remote. We trudged along thus for two miles or so, until mounting a rise we saw the phosphorescent glow of breakers and heard the ripple of the sea. A murmur went through the company: "The sea, the sea." I remember thinking at this time how the soldiers of Xenophon had expressed the same sentiment many hundreds of years before—perhaps Sir John Moore's men did so too.

We filed down to the beach, where we found thousands of men streaming along in the same direction as ourselves. It was like the children of Israel crossing the desert to the Red Sea, but it seemed extremely unlikely that the Straits would dry up and let us through. We stood and waited in the dark. Nobody had the faintest idea what to do, and it was like waiting in a queue at the booking office when one knows there is not much time before the train goes. Each of us felt that if he ruthlessly forged ahead he could probably get to the

front, but realized that it would be a mistake to do so. Consequently we just stood, and nothing happened. It need hardly be pointed out that by now we were thoroughly tired. We had been many days and nights without sleep, we had been in continuous touch with the enemy, and we had finished up with a tiring march through deep sand.

It must have been about two o'clock in the morning when we heard the drone of an aeroplane, and suddenly, breaking through the clouds, came a red ball of flame, dropped by an enemy reconnaissance machine. There flashed through my mind some quotation from the Book of Revelation: "I saw a star fall from Heaven unto the earth: and to him was given the key of the bottomless pit. And he opened the bottomless pit; and there arose a smoke out of the pit, as the smoke of a great furnace; and the sun and the air were darkened by reason of the smoke of the pit." As if in answer to this red flare dropped by the aeroplane, red rockets were fired up from the German positions to the south. We all expected a devastating crash of shells and bombs to follow; but for some obscure reason nothing occurred. We knew that we were a most wonderful target, and there seemed no prospect of the target growing less for a very long time. We now know that we are indebted to the R.A.F. for this. We saw very little of our 'planes, and it was not till much later that we realized how magnificently they had neutralized the German Air Force.

Gradually it became light, and there, perhaps a mile out from the shore, was a long line of ships waiting to receive us. They had all arrived in perfect order, risking the hazards of the sea and the enemy. We, too, had arrived in perfect order, but there seemed no link between us. Suddenly someone discovered at high-water mark some small boats resting on the sand. At this point on the coast the tide runs out almost a quarter of a mile, so that in the dark no one had seen them. We learned later that the beach staff who should have told us they were there had all been killed before we arrived.

There then began a kind of lido regatta. Soldiers surged around the boats, pushing them down to the sea, jumping in and paddling off in all kinds of unorthodox manners. Some boats were rowed forwards, some backwards; they drifted hither and thither, but all with the general purpose of getting to the ships. A flight of German fighters, nine or ten of them, appeared and swooped and dived, firing their machine-guns. The ships replied with A.A. guns and the troops on the beach fired with rifles and Bren guns at them. It was a regular Wild West scene, and if one had not been aware of considerable personal danger, it would have been most exciting.

By about seven o'clock I believe that most of my company had embarked on one ship or another. Then there was another attack by German fighters; we all scattered, and from then onwards it was

rather a case of each man for himself. The ships also moved off, presumably in accordance with their orders, and we straggled along the beach to Bray. Bray was like a village of the dead. It had been a seaside resort, with pretty villas, attractive cafés, and little shops; but every window was broken, many houses were in flames, corpses of men and beasts lay about the street, and there was a fusty smell of decay. We somehow collected our remaining men, got into a cellar, and told them to sleep while we planned what the next move should be. We numbered three officers and twenty men, though there were many men of other units wandering about, some in formed bodies, others like lost sheep.

Down on the beach we found the beach staff of another division, headed by a Colonel with four days' growth of beard and a strong Irish accent. He was sitting in a deck-chair with a cup of tea in one hand and a smoking Bren gun in the other. A German air raid had just ceased, and he said to me when I approached him, "You know, young man, I fire a lot of ammunition, but I don't seem to hit much." I asked him what he thought was the best thing to do with the remnant of the company that had not managed to embark at the proper place. He advised getting into any open boat and trying to row to England. Now this was not altogether a mad project, for there were some quite good-looking boats lying along the beach. We therefore collected our men, found two good rowing-boats, each about the size of a ship's lifeboat, and provisioned them with food, water, oars, anchors, and rope. There were masses of all this sort of thing lying about.

At about four o'clock (by now it was 1st June) the tide turned, and a soldier appeared driving a heavy lorry along the beach for no apparent reason. We therefore hailed him, tied our two boats behind his lorry, and told him to tow them to the sea as fast as he could. The enemy by this time was shelling the beach very heavily; he had got the range to a nicety, and the need for getting away was extremely apparent. The lorry went on with its own momentum into about six feet of water, towing the boats behind it. The driver jumped off the back of the vehicle into the leading boat, and we cast off the tow-rope.

From then onwards our adventures were fun. They were the kind that any yachtsman would enjoy and very few get the opportunity to experience. The tide was running in a westerly direction at a steady pace, and we were opposite Dunkirk by dark. At about ten o'clock we found two bigger and better boats drifting about in the sea, so we rowed up to them and anchored the whole Armada with the anchors and ropes we had brought with us. I then dished out the rations to the troops—there were twenty-eight all told—in the best Captain Bligh style with a pistol in one hand. We had enough food

for two days and a half if we used it carefully. I reckoned we should get to Dover in four favourable tides—that is to say, about two days—so with reasonable care we had nothing whatever to worry about. After we had fed we transferred the men into the bigger and better boats and cast our original ones adrift.

The tide was against us for the next six hours, so there was nothing to do but to lie in the boats and sleep or watch the fireworks in Dunkirk. These were most impressive: there were star-shells, there were fires, there was the flash of shells bursting and the flash of guns firing in retaliation, and to crown the lot there was one enormous fire that looked as if it might have been a petrol reservoir.

At 1.30 in the morning of 2nd June the tide was again favourable, so we pulled up the anchor and continued on our course. After we had been rowing for about two hours we came across a naval pinnace abandoned in the sea. We boarded this, and found it still provisioned with food and water. The occupants had evidently made a very hurried departure. There was blood on the deck, clothes strewn about the cabin, the steering-gear was out of order and the charts and the compass had gone. However, it was a much more suitable craft than any we had been in, so we set about to investigate whether we could make it work. One of the soldiers with a mechanical turn of mind discovered that the engines, which were high horse-powered Diesel engines, were undamaged and would start. Someone else discovered that by standing right in the stern of the ship it was possible to control the rudder with an iron bar. We therefore transferred our men, started up the engines, and set off in a north-westerly direction into the North Sea. We reckoned this would get us to Harwich.

When we had been going for about an hour a soldier who had been posted as a look-out in the bows shouted, "Land ahead," and we all peered through the early morning haze at what appeared to be mud-flats with some trees growing on them, not unlike the coast of Essex. As we approached, however, we discovered that the mud-flats were a sunken ship lying on its side, and that the trees were the masts and funnels of another ship sunk beyond it. We were cruising round this wreckage to see if there were any survivors when a warship appeared. Her captain shouted from the bridge to ask if we needed any help, and with incredible weakness of mind we agreed to abandon our pinnace and allow him to tow it to port. We therefore climbed aboard, and the men were given tea by the ship's company and the officers coffee in the wardroom. Here, I am sorry to say, we fell asleep, and when we woke up we were in Dover. The captain had gone ashore for orders, and a train was waiting to take us all to our destinations in England.

When we first saw the warship in the distance, of course we

assumed it was British. The mere possibility of its being Bosche never occurred to us. Such is the reliance of the British upon the Royal Navy—a reliance about which little is said and very much taken for granted. But no account of the events at Dunkirk would be complete without a reference to two factors that made the evacuation possible: one is the stout heart of the Royal Navy; the other is divine intervention, made manifest in the perfect weather and calm sea. And if one puts one's trust in God and the Royal Navy one cannot go far wrong.

*THE GERMAN PASSAGE OF THE DANUBE 22nd–26th NOVEMBER, 1916.**

(With Map.)

By BRIGADIER-GENERAL SIR JAMES E. EDMONDS, C.B., C.M.G., D. LITT. (*Oxon.*), *p.s.c.*†

THE passage of the Danube by five divisions of General-Field-Marshal von Mackensen's Balkan Command in November, 1916, affords a good illustration of the careful preparation of this kind of operation by the German General Staff, when plenty of time—in this case four months—is available to think out details. As such, and as a clue to landing operations, it is deserving of study. Although " the undertaking met with hardly any resistance and no casualties were suffered " (Immanuel, *Der Weltkrieg*, page 191), it by no means ran " according to plan " : for four hours a battalion and a half of German infantry stood alone on the Rumanian shore. Had only trifling resistance been offered by riflemen, the operation would have been a costly failure. Unfortunately, the attention of the Rumanian leaders was directed elsewhere.

The general situation in the Balkan theatre previous to the passage was that General von Falkenhayn's Ninth Army which, with the Austro-Hungarian First Army on its left, was invading Rumania, had by the 17th November forced the two westernmost passes of the Transylvanian Alps, Rumania's northern frontier, and thus turned her northern line of defence ; in the Dobrudja (then Rumanian), the Germans and Bulgarians faced Russians and Rumanians between the sea and the Danube near Braila, whence westward past Silistria and Sistov (the place of crossing) to the Serbian frontier, the river formed the boundary between Rumania and Bulgaria. The British and their Allies were holding Salonika, reinforced in May by six divisions of the Serbian Army which, driven out of their country in 1915, had reorganized in Corfu.

To assist the Transylvania operations a crossing of the Danube at Sistov, the formation of a bridgehead there and a dash on Bukarest by a small force had been projected early in October, but rejected by Mackensen, who was in command of the troops of the Central Powers south of the Danube, as, being engaged on the Dobrudja front, he could spare only " modest forces."

* *The German Official History*, Volume XI ; the *Austrian Official History*, Volume V ; Regele's *Kampf um die Donau* (which takes up the Rumanian accounts) ; Bose's *Flussübergänge im Weltkrieg ;* Falkenhayn's *Der Feldzug der 9. Armee gegen die Rumanen und Russen* 1916–17 ; Foerster's *Mackensen* ; Kabisch's *Der Rumänienkrieg* 1916, etc.

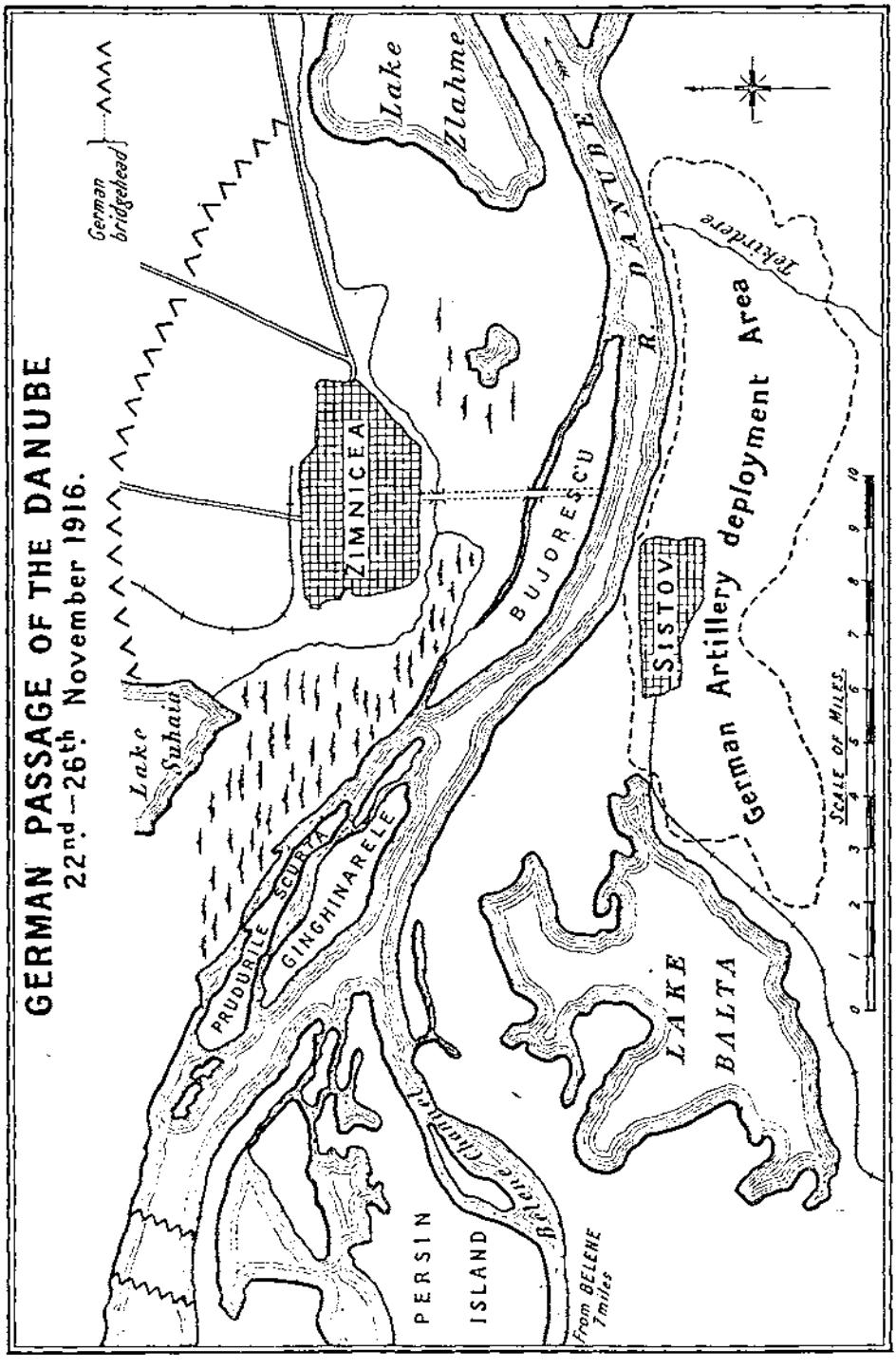
The situation on the Dobrudja front towards the end of October being stabilized, but the two German-Austrian Armies held up " without satisfactory progress " in the Transylvanian Alps, on the 22nd October the German Supreme Command (Hindenburg-Ludendorff had taken over from Falkenhayn on the 29th August) ordered the preparations for bridging the Danube to be continued, and at the end of the month Mackensen found that he could spare two divisions from the Dobrudja front in addition to the one already available. On the 13th November he issued formal orders to General Kosch, commanding the LII. Corps, now renamed the Danube Army, to force the passage at Sistov, giving the 22nd November as the probable date. On the 14th November, O.H.L. directed Mackensen to use three divisions and cross at some date after the 20th and before the 25th. He chose the 23rd. Actually, five divisions, the German 217th, the Turkish 26th (a very good one), and the 1st and 12th Bulgarian, with v.d. Goltz's mixed cavalry division (18 squadrons, 7 infantry battalions, etc.) were assembled.

As the situation in the Transylvanian Alps had changed for the better, the date for the crossing of the Danube was made dependent on the progress of the right of Falkenhayn's troops: his Ninth Army was changing front from facing south to facing east by a left wheel, and when its right reached the Alt river (which flows south into the Danube about 40 miles above Sistov) the Danube Army was to begin crossing. The Danube and Ninth Armies, after the former had wheeled to the right and established touch, were to advance eastwards across Rumania.

Although Rumania did not make her first declaration of war against Austria until the 27th August, " already at the conference of the Chiefs of the General Staffs [of the Central Powers] on the 18th July the crossing of the Danube at Sistov had been declared an inevitable operation " (Regele, page 102).* After the 27th August the German 101st Division, then in Eastern Bulgaria, was directed to form with local Bulgarian forces a " Danube Security " force, to watch the course of the river from the Iron Gates down to Ruschuk, 30 miles below Sistov, and make preparations for a crossing at Sistov. The 12th Bulgarian Division (of *Landwehr*) and a German mixed brigade (von Kaufmann) were soon added to the " Danube Security " in order to continue the watch below Ruschuk and establish connection with the Bulgarian Third Army in the Dobrudja. The river was also guarded by the " Danube Flotilla," the part of which took part in the crossing consisting of 45 vessels: 12 monitors, 4 patrol " vedettes," 4 armoured steamers, 8 minelayers and sweepers, 5 counter-mine rafts, 5 motor launches and 7 steamers for supply, hospital and headquarters.

The lower Danube has been crossed many times by Armies. The

* According to W. Foerster's *Mackensen*, page 288, the Field-Marshal chose Sistov as the locality " in August."


GERMAN PASSAGE OF THE DANUBE
22nd–26th November 1916.
German bridgehead
Lake Zlahme
ZIMNICEA
BUJORESCU
R. DANUBE
Tekirdere
SISTOV
German Artillery deployment Area
Lake Suhaia
PRUDURILE SECRTA
GINGHINARELE
PERSIN ISLAND
Channel
Belene
From BELENE 7miles
LAKE BALTA
SCALE OF MILES
0 1 2 3 4 5 6 7 8 9 10

Russians, in the Turkish War of 1877, had actually crossed at Sistov, but from the north to the south bank, for which the conditions were not quite so favourable as in the opposite direction which offered many advantages.

Though the adjacent country was flat, on the Rumanian side marshy, the southern bank was slightly higher than the northern, with some low hills south of Sistov, and the width of the Danube, 880 to 1,000 yards, was sufficient to protect the preparations from close observation. The current was only a little over half a mile an hour. The Belene Channel, covered by Persin Island (about eight miles by three) was an ideal place for the assembly of the bridging material and for the training of the troops. Ginghinarele Island, which was captured from its small Rumanian garrison on the 8th October, protected the exit from the channel. East of Sistov the Tekirdere stream also offered a haven for boats. Railways and several good roads led to Sistov and from Zimnicea, all above high-water level, and a bridgehead could quickly be formed between Zlahme and Suhaia lakes. On the other hand, everything depended on successfully floating the bridging and ferry apparatus out of the narrow exit of the Belene Channel, 130 yards wide, where it was to be assembled; and the first landing places, although the banks were sound, were limited by marshes and entailed crossing two water-courses, one 220 feet wide and 13 feet deep, and another 100 feet wide, with the old fortifications of Zimnicea behind it.

A large amount of bridging material was collected in two groups, the work being begun as early as the 24th July, 1916 (Regele, page 117), under the Austrian Major-General Gaugl: one German and 15 Austrian bridging trains, 1,815 metres of Herbert heavy road bridge,* and 1,500 metres of "spare" bridge.† There were also 6 steam ferries,‡ 2 steam tugs, 1 motor tug and a headquarters steamer, 3 motor launches for the staff and 2 cable boats, 26 kilometres of field railway, with a field railway company, a telegraph detachment, medical detachments, post, bakery and butchery units, and 7½ engineer companies specially reinforced by sections from 4 battalions, 250 seamen and a labour company. The greater part of the material was collected at Belene§ between the 3rd and 10th August, that is before declaration of war.

A mass of 60 batteries was assembled, 124 field guns, 87 heavy of all calibres up to 16-inch (two), mostly placed in the area around Sistov, with a few on the islands; also 97 guns on the Danube Flotilla, but with only 2 anti-aircraft guns, excluding those on the

* A bay of this, 25 metres long, was formed by two large pontoons, each made up of seven small ones, with two light lattice girders resting on them: in bridge the pontoons of adjacent bays were 13 feet apart.

† "Behelfsbrücke," apparently used for peace time emergencies, consisting of 22.5 metre span bow-strung girders, resting on barges or trestles.

‡ These steam ferries belonged to the Danube Navigation Company, and towed four 65–67 ton barges.

§ On the Belene Channel, just off the western edge of the map.

flotilla. The air forces consisted of Air Detachments 28 and 243A, the German Fighter Squadron No. 1 (24 machines) and the Austrian Air Company No. 36.*

The preparatory work of the engineers begun in the middle of August, was :—

1. The fortification of Persin Island, Schuwen Island above it, and the small islands in front of them, in order to cover the assembly of bridging material in Belene Channel.
2. Protection of the above sector ; for which purpose machine guns were issued to the engineers.
3. Maintenance of communication between all the occupied islands ; construction of landing places on them and on the south bank of the Danube ; collection of all boats of the inhabitants.
4. Organization of instruction in field fortification for the Bulgarian 12th Division.
5. Technical reconnaissance and observation of the Danube from Nikopol (25 miles above Sistov) to Ruschuk (33 miles below Sistov).
6. Reconnaissance, camouflage and signboarding of the assembly places for the landing parties.
7. Instruction of the landing parties in the various methods of transport.
8. Construction of dug-outs and O.P's for the various staffs.
9. Camouflage in the assembly areas.
10. Construction and repair of roads, paths and bridges.
11. Erection of poles for the new telephone lines.
12. Removal of particularly conspicuous objects on the south bank (poplars, isolated houses, etc.) which might serve the enemy's artillery as reference points.
13. Laying out of booms across the Danube above Sistov, above Belene, and in Belene Channel, and of two dummy booms. Two booms at Ruschuk, to prevent the Rumanian flotilla returning, were also constructed.
14. Collection of engineer bridging material.
15. Fitting of country carts for the transport of pontoons into Sistov.
16. Forming the Herbert bridge material into rafts.
17. Collection of stores to form tow rafts for the steam ferries.
18. Preparation of the steam ferries, tugs and the making of gangways.
19. Preparation of portable footbridges, ladders and portable obstacles for the operations on the north bank.
20. Construction of huts for the field railway, field post, bakery and hospitals.

* The total number of machines is not available.

The general plan was as follows, starting at 6.30 a.m. (twenty minutes before sunrise): *On the first day* to row over the fighting troops of two divisions in pontoons in 6½ hours, and in the next 5½ hours to transport a third division by means of the steam ferries (which towed barges up to the number of six), and in the following 5½ hours (6.30 p.m. to midnight) a fourth by the steam ferries. *On the second day*, the fifth division, starting at 6.30 a.m., would be taken over on the steam ferries. The Herbert bridge was expected to be completed by 6.30 a.m. on the second day, and the trains of the divisions and the Army troops would cross by it.

With the number of pontoons available, about 2,832 men could be transported at a time, making 14,000 in five trips. The empty pontoons were to be rowed or towed back.

It was calculated that there would be landed on the north bank :—

at 6.45 a.m.	..	1,084 men	12,218 men in 4½ hours.
6.55 ,,	..	1,160 ,,	
7.0 ,,	..	1,232 ,,	
8.15 ,,	..	1,232 ,,	
8.30 ,,	..	1,160 ,,	
8.45 ,,	..	960 ,,	
9.0 ,,	..	1,160 ,,	
9.15 ,,	..	1,410 ,,	
10.15 ,,	..	1,410 ,,	
11.15 ,,	..	1,410 ,,	

That is :—

from 6.45 to 6.55 a.m. 2,244 men of the 217th Division.
,, 7.0 a.m. to 8.15 a.m. 2,464 men of Goltz Division.
,, 8.30 a.m. to 9 a.m. 3,280 men of the 217th Division.
,, 9.15 a.m. to 11.15 a.m. 4,230 men of Goltz Division.

The work of transport was distributed among the engineer companies as follows :—

124 men by the Reserve Engineer Co. 17, in one trip by rowing ;
1,920 ,, by Engineer Co. 6/2, in two trips by rowing ;
3,480 ,, by Engineer Co. 2/5, in three trips with motor-boat tow ;
6,694 ,, by Colonel Myk's Engineer Group (Austrian bridging trains) in five trips by rowing and motor-boat tow.

A specimen of the steam ferry loads, the six being in charge of an engineer company, is as follows :—

No. 1 (with drop gangways) : 2 battalions, 12 machine guns, divisional bridging train, portable obstacles. Followed by 2 tugs with portable landing bridges, 2 to be dropped to the right and 3 to the left of the central road.

No. 2: 3 cavalry officers' patrols, 1 field battery, telephone detachment, field ambulance.
No. 3: 1 field battery, 1 light ammunition column.
No. 4: 1 field battery, the personnel of a pontoon train.
No. 5: Half a *Jäger* battalion, riding and draft horses, field kitchen.
No. 6: Baggage, ammunition and engineer stores.

A number of "beach officers" were detailed for both banks.

For work on the north bank, one German engineer company and most of the Bulgarian engineers were detailed with 10 lorries of stores for the fortification of the bridgehead; when the advance from the small bridgehead was begun, 2 engineer companies with pontoons were to accompany it.

The deployment of the batteries was completed by the middle of November; two field batteries were placed on Ginghinarele Island; to aid surprise, fire was not to be opened until the operation was in progress and it was clear that the enemy had recognized a crossing was being attempted.

Besides a complete telephone system on the south shore, a two-core cable was laid to Ginghinarele Island. On the 23rd November this was to be extended to the north bank, and two single-core cables from Tekirdere, and a seven-core cable from Sistov to the north end of the bridge laid. One boat of the Danube flotilla had wireless apparatus, which could be used to send messages from the north to the south shore.

No special equipment was issued except a life-belt for every fifth man; but every pontoon and ferry boat was to transport sandbags, and the men carried rather more tools and grenades than usual, besides wire and pickets, telephone poles and wire, all of which they were to lay down on landing. Five days' supplies were provided regimentally.

All this work was carried on without interference from the Rumanians. Their outposts on the river reported a great deal of noise on the nights preceding the crossing. For the whole sector from the Alt river, 40 miles above Sistov to the Vede, 30 miles below, only one infantry brigade, the 43rd, was available, and in the Zimnicea subsection, the one concerned, were only two Landwehr battalions, one field battery, one 4-inch battery, one cavalry troop, with a general reserve of three battalions, two light batteries and two cavalry troops, 25 miles in rear.

The Rumanian flotilla was with the Dobrudja forces, and no aeroplanes were available.

At 3 p.m. on the 22nd November, in thick fog, the embarkation of the first echelon of the 217th Division, to form up on Persin and Ginghinarele Islands ready for the crossing, was begun at Belene. The troops had great difficulty in finding their way from the bivouacs to the piers, three miles away; so that it was 5.30 p.m., an hour

and a half late, before the pontoons got off. They formed a column half a mile or more long, and the engineer officer in charge caused further delay by stopping them near the south bank opposite Ginghinarele to count them, and it was 8 p.m. before they rowed on, and midnight before the troops were established on the island. Four pontoons went astray in the 10-mile pull, one of which contained the battalion staff; but obtaining a passage in a motor boat, the commander arrived at 5 a.m. on the 23rd.

The second echelon, which had to reach positions on Persin Island, 7½ miles away, though its column was 600 yards longer, thanks to some motor boats which accompanied it, reached its destination without incident by 11 p.m.

Goltz's division, which was to be on the right of the 217th in the bridgehead, spent the night in bringing its pontoons down to the banks of the Danube below the bridge site; and by early morning all was ready; but a Bulgarian detachment in the division declined to embark.

Corps headquarters had given an order that if weather conditions made a crossing impossible it should be reported by 6.15 a.m.—leaving only 15 minutes to order a postponement. The corps staff should of course have been on the spot to make the decision.

At 5 a.m. all the echelons were in position for the crossing and hardly a shot had been heard. The fog had not lessened, but the senior engineer officer with the first echelon of the 217th Division proposed to obey orders and start.* His opposite number in Goltz's division, however, at 5.55 a.m. reported to the corps: "Thick fog on the Danube; dark, no visibility. At present crossing impossible." At 6.15 a.m. the corps commander decided to postpone operations for two hours. His counter-order reached the 217th Division headquarters at 6.25 and then had to be passed on to Ginghinarele and Persin Islands, by which time the first pontoons of both the first and second echelons had already started. Actually soon after 6.45 a.m. 400 *Jäger* (there should have been 1,600) were on the north bank, and one sapper only had been wounded by a bullet. As the engineer officer in charge of the pontoons was taking them back empty he received a hail from a monitor: "Crossing postponed two hours." He was puzzled what to do: whether to return and pick up the *Jäger*, who had vanished into the fog as soon as he had landed them; or to continue on. He decided on the latter course, and at 7.30 a.m. reported to the C.O. of the *Jäger* battalion, who telephoned to divisional headquarters, where ten minutes earlier the departure and safe arrival of further portions of the two first

* In 1908 the writer was present at a crossing of the Rhine and the construction of a pontoon bridge below Coblenz, where it is 380 yards wide, at dawn in a thick fog. The infantry, in full equipment, without any safety precautions, such as life-belts or piquet boats, were embarked on pontoons, rowed by four sappers and aided by the current made singly for the further shore. The first part of the bridge was swung, and the rest constructed by floating down sections to the head.

echelons had become known. After a staff officer had interrogated the engineer officer, at 8.10 a.m. the corps was informed of the successful landing, and General Kosch at 8.30 a.m. ordered the continuation of the crossing regardless of fog.

The first echelons of Goltz's division then embarked according to plan; but subsequently the strict programme was abandoned, and as pontoons became available on return to the south bank, any troops were at once put into them and sent over. About 10.30 a.m. the proceedings were expedited by the motor boats being detailed to tow the empty pontoons back. The general result was that the 217th Division troops completed the passage at 12.5 p.m. instead of 10 a.m. and Goltz's at 1 p.m. instead of 11.15 a.m.

Many difficulties occurred in sending off the steam-ferries. No.1 did not leave until 10 a.m., and between 1 and 2 p.m. landed 2 battalions and 12 machine guns at the western end of Bujorescu Island by means of gangways, and then had to be ferried over the Bablea in pontoons. The three landing piers, owing to the delay due to the fog in bringing over material, were not finished until 3.30 p.m., 5 p.m. and 5.15 p.m. respectively. Nos. 2 to 5 steam-ferries landed their passengers at the first pier between 4 and 6 p.m. No. 6 went aground in Belene Channel, and as its tug damaged one of its paddle wheels, it was 10 a.m. on the 24th before it reached the north bank. No. 1 went astray on its return journey and did not complete its second and third trips with troops of the 1st Bulgarian Division, which had refused to embark on pontoons, until 4.15 p.m. and 9 p.m. respectively. The steam-ferries were not used during the night, but other traffic continued.

Resistance had been slight; but, owing to the fog, the advance of the troops, led by reconnaissance patrols, had been slow. By 2 p.m., however, Zimnicea had been occupied, and by 4 p.m. the first bridgehead had been occupied.

"By late evening about 17 battalions, with at least 80 machine guns and 3 batteries, were on the north bank. A set-back was no longer to be feared." About a hundred prisoners and one gun had been captured. The crossing was continued on the 24th.

The preparations for the bridge were begun on the 23rd and the corps ordered that it should be completed by 10 a.m. on the 25th. The 8¾-mile journey from the Belene Channel in the fog amid a mass of vessels proved tiresome. Two sections ran ashore. The throwing of the bridge could not therefore be begun until 7.20 a.m. on the 24th, but was completed by 6 a.m. on the 25th, the engineers working throughout the night. By evening the whole of the 217th Division, Goltz's division, 4 cavalry regiments, the Bulgarian 1st Division and the Turkish 26th Division were on the north bank, and the Bulgarian 12th Division followed on the 26th; the fighting part of two divisions had been ferried over on the 23rd and 24th; the rest of the troops with the mass of the artillery crossed by the bridge.

PROGRESS REPORTS ON FIELD SERVICE.

By BRIGADIER J. D. INGLIS, O.B.E., M.C.

"The execution of any but the smallest engineering work calls for attention to the following measures :—

* * * * * * *

(ii) The design of the work, with estimates of the time, labour, stores and transport necessary for its execution.

* * * * * * *

(ix) The submission of regular progress reports and of a completion report."

(*Extract from E.T.* 86.1.)

PROGRESS REPORTS AN ESSENTIAL PART OF ENGINEER INTELLIGENCE.

THERE is a widespread tendency amongst R.E. officers to regard the progress report as just another return. It is often left to the office staff to produce, sometimes punctually, more often late and inaccurately. It is regarded as an unimportant matter compared with "getting on with the job." Information as to progress is an essential ingredient of engineer Intelligence and deserves more attention than it usually receives. In war, the demand for engineer work invariably exceeds the engineer resources. Moreover the completion of a task in time is essential to the success of the military plan. Consequently, Engineer Commanders and Advisers are constantly asked two questions :—

(1) When will the job be finished ?
(2) When can they start the next job ?

The plans of the General Staff and their success or failure frequently depend upon a reasonably accurate answer to these two questions.

INFORMATION AVAILABLE IF WORK PROPERLY ORGANIZED.

It is well known that there are always a number of factors outside the control of the engineer which will affect the time required to complete a job. In spite of this, the officer in charge of the work is in a better position to estimate the probable time of completion than the various engineer staffs of higher formations. According to the

breadth of his experience, the engineer will be able to anticipate the extent of delays from unforeseen causes.

Some estimate of time, labour, plant and materials is essential to the proper organization of any engineering work. Failure to make such an estimate is almost certain to result in delays, uneconomical employment of labour or a belated discovery that the job will not be finished in time to serve its purpose. Having made an estimate, a system of progressing is required to show whether the actual work is keeping pace with the estimate or whether additional plant or labour is required to ensure punctual completion. An engineer who omits to do this cannot organize the work efficiently. It is true that works are frequently completed in time by engineers who do not believe in estimates and progress charts. Instead, they make a guess and ask for four times the labour and plant required, knowing that they will get half that amount, and hoping it will be enough. This plan often works well and brings great credit on its author, but, bearing in mind that in war the demands for engineers invariably exceed resources, it is not efficient because it is extravagant.

FAILURE TO REPORT PROGRESS CAUSES UNNECESSARY CORRESPONDENCE.

The absence of reasonably reliable progress reports results in a perpetual demand from higher formations for information, both as to the progress of work and the availability of engineers' resources for new work. Time is wasted in obtaining information in this way, plans are often necessarily made before the information is forthcoming and have in consequence to be modified subsequently.

It is often said that correspondence is the curse of the Army and that it prevents officers from exercising proper supervision over their commands. Few officers realize that the correspondence which they regard as so unnecessary has been initiated through their own failure to give systematic and accurate information.

REASONS FOR RECORDING AND REPORTING PROGRESS.

It is clear, therefore, that :—

(i) Timely and accurate information as to progress is necessary, both for the General Staff to make their plans and for the Engineer Staff to control the work.

(ii) The engineer in charge cannot organize the work properly unless he has this information.

(iii) If this information is sent back to higher formations punctually, accurately and systematically, correspondence will be reduced.

The Aim of Progress Reports.

Some engineers regard progress reports as a means of self-advertisement. Their reports comprise a catalogue of difficulties surmounted, failures explained away, and successful achievements. These are matters for the War Diary or for Army Form W.3121 rather than for Progress Reports.

There is a popular idea that it is better to refuse to give any forecast of a completion date than to give one which afterwards proves wrong. This attitude overlooks the fact that a task always looks easier from a distance than it really is. If the engineer in charge refuses to say when the finished work will be ready, somebody else will have to make a guess; that guess is likely to be an underestimate and to cause the engineer in charge a great deal of trouble. It is, moreover, essential that the staff shall at least know the date of completion at which the engineer in charge is aiming; that date may not suit their plans and it may be necessary to divert other engineer resources to accelerate the work.

The object of a Progress Report should be :—

(i) To give an up-to-date picture of the state of progress, so that the staff can be informed of the situation as it is.

(ii) To forecast the date of completion as accurately as the information available at the time permits.

(iii) To state any qualifying factors outside the control of the engineer in charge. This may enable the staff to improve the accuracy of the forecast of completion.

(iv) To record the employment of units and, if necessary, sub-units. This will enable the staff to base their orders for priority of work on sound information as to the dates on which units will be available for other work.

(v) To record accurately time and labour and so furnish data on which to base future estimates.

Standardization of Form.

It is desirable that the progress reports submitted to any formation by lower formations executing the same class of work should be of a standard form. It is not possible to lay down a standard form for all reports, because it must vary in different circumstances. Nor is it always possible to decide upon the best form at the outset of the work. It usually happens therefore that, when the work has been in progress for some time, a higher formation calls for progress reports in a particular form. This is liable to require changes in the form of report already being submitted, all through the chain of command; this causes confusion and extra work and is to be avoided as far as possible. It is preferable therefore, in the first place, to call for a

progress report stating the frequency and the scope but without specifying the form, relying upon the training of the engineers of subordinate formations to produce a report in which no essential will have been omitted. It will then be necessary to alter the form only in the case of those formations which have omitted essentials. Thus will they learn to do better next time.

With the object of assisting the reader to reach this ideal, the considerations affecting the form of a progress report have been set out below :—

(i) The more complex the work and the greater its magnitude, the greater should be the detail and sub-division into tasks.

(ii) The higher the formation receiving the report, the less the detail and the sub-division required.

(iii) The longer the duration of the work, the less frequent the reports.

(iv) Difficulties in obtaining certain classes of labour, plant and material will necessitate special emphasis of the items which they affect.

With these considerations in mind it is possible to deduce a skeleton form of progress report. The points to be covered are :—

(i) By whom and to whom the report is made.

(ii) A short title of the work covered by the report.

(iii) The labour, skilled and unskilled, employed during the period covered by the report ; in the case of military labour, this should be given in units and sub-units ; in the case of civilian labour, in actual numbers.

(iv) The date or time of commencement of the work.

(v) The total programme of work ordered.

(vi) The state of progress at the time of the report. This may be given either numerically, or as a percentage of the total programme or in the form of a narrative. Percentages should be based on a systematic assessment and not merely on casual observation. An example of such a systematic assessment is contained in the sample report at Appendix " A," para. (*a*). This and Appendices " B," " C " and " D " contain typical progress reports on other classes of work.

(vii) Estimated date or time of completion. Care should be taken not to base the completion date on assumptions which are obviously unlikely to be fulfilled. It is better to face facts.

It should be quite clear to what force of labour the completion date is related, *i.e.*, to the existing force or to some promised or expected addition.

(viii) Any assumptions on matters outside the control of the officer making the report, upon which the completion date depends, should be included when relevant; but obvious remarks such as "weather permitting," or "assuming no additional work is ordered," are unnecessary.

(ix) Requests for extra assistance or materials should not be included but should be sent separately, but it may be advisable to refer to them when they are specially relevant.

(x) It is impossible to be dogmatic as to the sub-divisions of work in which reports should be made. There are two aspects to consider:—

(*a*) The point of view of the staff who require the information to make their plans.

(*b*) That of the Engineer Staffs of higher formations who have to organize their resources.

The report should always be sub-divided into the parts which have a separate use, the completion of which is therefore of interest to the staff.

A further sub-division may be necessary, corresponding to the size of the units employed. For example, a C.R.E. reporting to his General Staff should sub-divide at least into the portions of the work representing Field Company tasks; similarly a Field Company Commander should sub-divide at least into section tasks, so that the C.R.E. will know when a further section task can be started.

(xi) In cases where it is not obvious from the rest of the report, the date on which a portion of the labour or plant will probably be released for other works should be given.

It is clear that not all of the foregoing are applicable to every report.

(i), (ii), (vii) and (viii) are essential to all reports.

(iii), (iv) are essential in a work of any magnitude, to provide a record of time and labour to facilitate future estimates.

(v) is essential unless it is implicit in (ii).

(vi) is essential in works of long duration, when the report will be examined by the Engineer Staffs of higher formations, who will want to satisfy themselves that the date of completion given is reasonable. It is usually unnecessary in operational tasks of short duration, when the time of completion is all that matters.

(ix), (x) and (xi) are of general application.

Normally a tabulated form of report is to be preferred; a plan often clarifies the report, particularly in the case of base installations, camps, etc., where it is desirable to give a clear picture of the state of partial completion reached.

In the case of road construction, a chart is usually employed which shows the progress of each process, *e.g.*, formation, soling, consolidation of surface, etc., along the whole length of the road. This can conveniently be arranged by a periodical exchange of charts. The progress on bridges and culverts is better shown in tabular form.

METHOD OF TRANSMITTING REPORTS.

Commanders of formations are responsible for the work of the R.E. units under their command. Progress reports compiled by C's.R.E. are therefore transmitted through staff channels. Up to the C.R.E. they pass through R.E. channels, except in the case of R.E. officers or units under the command of formations. For example, the O.C. of a Field Company under command of a Brigade or of a D.C.R.E., in a base sub-area where there is no C.R.E., submits his reports to the commander of the Brigade or base sub-area, whose staff transmit them to higher formations.

Rapid transmission is essential; punctual submission is therefore important because the consolidation and onward transmission to the next formation cannot be effected until the last report from lower formations is received. To ensure this it will on occasion be necessary to report by signal, in which case some form of code should be devised to reduce the length of the signal.

SUMMARY.

The success of the plan of the General Staff depends on an accurate and up-to-date knowledge in all formations of the progress of R.E. work. This information is also necessary to enable the R.E. to organize the work efficiently; it should therefore be readily available. If it is sent back systematically, accurately and punctually, much correspondence will be avoided.

Progress reports should contain all the essential information on which to base the plans of the staff and to enable engineer staffs to organize their resources; they should not be a record of past achievements. Submission should be punctual and transmission speedy.

Although progress reports are closely connected with the whole basis of the proper organization of engineer work, their neglect is widespread. For this reason the writer makes no apology for inflicting on his readers, if indeed he has any, a subject so dull.

APPENDIX "A."

PROGRESS REPORT.

BASE INSTALLATIONS.

(*a*) O.C. No. 1 Sec. to O.C. X Army Troops Coy. R.E.
Progress for week ending 17.3.40.
Job: No. 1 B.S.D. Whisker "A."
Labour: No. 1 Sec. (less 2 Sub-secs.).
Employed since last Report: 2 Secs. No. Y. A.M.P.C. Coy. till 14.3, then 3 Secs.

Date of Commencement.		Shed No. 1: 14.1.40	Shed No. 2: 14.1.40	Shed No. 3: 20.2.40	Shed No. 4: 20.2.40	Shed No. 5: 1.3.40	Remarks.
Job.	Percentage of whole Building.	Percentage Progress on Shed No. 1	2	3	4	5	
Levelling site	15	15	15	15	15	12	An additional concrete mixer would accelerate completion date.
Foundations	10	10	10	5	5	–	
Framework	25	25	25	5	–	–	
Covering	10	10	7·5	–	–	–	
Floor	15	15	5	–	–	–	
Glazing	5	5	1	–	–	–	
Doors	2·5	2·5	–	–	–	–	
Internal E.L.	5	2·5	–	–	–	–	
Internal W.S.	2·5	·5	–	–	–	–	
Painting	10	5	–	–	–	–	
TOTAL	100	90·5	63·5	25	20	12	

Probable date of completion: 30.4.40.
Date: 17.3.40.

Note.—The estimated percentage which each part of the building is of the whole, is fixed for each type of building at the commencement of the work. The engineer in charge enters this figure in column 2 of the Report. Some adjustment of this figure may be necessary in the light of experience gained as the work proceeds. He can then enter a reasonably correct percentage progress figure opposite each item. For example, when levelling of site is complete on No. 1 Shed, he enters 15. When the foundations are half complete on No. 3 Shed, he enters 5, and so on. The total percentage progress on each shed is in this way obtained with very little trouble and with much greater accuracy than by attempting a mental estimate of the progress on the whole building.

(*b*) O.C. X Army Troops Coy. R.E. to C.R.E. Base Sub-area.
Job: No. 1 B.S.D.
Labour: X Army Troops Coy. R.E.
2 Coys. A.M.P.C.
Date of commencement: 15.12.39.

Job.	Percentage Progress.					Remarks.
	External.	Whisker A	Whisker B	Whisker C	Whisker D	
Roads	75	100	100	75	50	Bulldozer can be released on 24.3.40.
Water supply ...	100	75	75	25	25	
E.L. supply ...	—	—	—	—	—	E. and M. Sec. awaited; will delay completion if not received by 1.4.40.
Sewerage	—	50	50	40	20	
Shedding	—	42	40	30	20	
Probable completion date		14. 5. 40.	14. 5. 40.	14. 6. 40.	14. 7. 40.	

Date: 19.3.40.

(*c*) C.R.E. Sub-area to C.E. L.-of-C.

Job.	Unit Employed.	Date of Commencement.	Percentage Completion.	Probable date of Completion.	Remarks.
No. 1 B.S.D.					
Whisker A.	X Army Troops Coy. U. & V. Coys. A.M.P.C.	15.12.39	60%	31.5.40	
,, B.			60%	31.5.40	
,, C.			40%	14.6.40	
,, D.			25%	14.7.40	
No. 6 B.A.D.					
Whisker A.	Z Army Troops Coy. Y. & W. Coys. A.M.P.C.	14.10.39	100%	31.1.40	Estimate that Z Army Troops Coy., less 1 sec. Y A.M.P.C. Coy., W A.M.P.C. Coy. less 5 secs., will be available for other work about 31.3.40.
,, B.			100%	15.2.40	
,, C.			100%	29.2.40	
,, D.			100%	14.3.40	
,, E.			90%	31.3.40	
,, F.			75%	15.4.40	
Etc.					

Date: 25.3.40.

(*d*) The form of the Report from C.E. L.-of-C. to D.W. would be the same as (*c*) but would be consolidated. The anticipated dates of completion might have to be modified in the light of knowledge as to the availability of resources known to the C.E. and not known by his C.R.E's. The Remarks column would, of course, be appropriately modified.

APPENDIX "B."

INITIAL DEVELOPMENT OF A DEFENSIVE POSITION.

(i) Reports from Section Officers to O.C. Field Coy. would be verbal.
(ii) From : O.C. X Field Coy. R.E.

To : C.R.E. Y Corps Troops.
P.R.3 15/5

Progress, G.H.Q. Line. A Sector(.) Weapon pits and protective wire complete(.) Fire-bays to stage one and crawl C.T's. complete in localities Hill 226 GREEN FARM in hand at LITTLE WOOD and PRETTY CORNER(.) Tactical wire F.D.L's. 500 yds. complete, 300 yds. projected(.) All 8 A.Tk. gun concrete pillboxes in hand(.) Troops employed X Fd. Coy. R.E., 2 Coys. 2/RUR, 5 3-ton lorries Corps Tps. Supply Col(.) Expect completion of approved plan to stage one fire trenches and crawl C.T's. in all defended localities by 24/5 with above labour(.) Excavators for A.Tk. ditch awaited 900 yds. of standard ditch required.
T.O.R. 2200 hrs.

(iii) From : C.R.E. Y Corps Troops.

To : Y Corps.
P.R.3 15/5

Progress, G.H.Q. Line weapon pits and protective wire complete all sectors(.) A.Tk. ditch in sectors B. and D. and A.Tk. gun pillboxes in all sectors started(.) Require, by 17/5, four more Excavators $\frac{5}{8}$ yd. to complete all sectors by 26/5(.) Completion all sectors to approved plan up to stage one fire trenches and crawl C.T's. in all defended localities by 26/5 assuming retention present resources.

(iv) From : Y Corps.
To : Z Army.

Progress, G.H.Q. Line Sectors A. to D.(.) Weapon pits and protective wire complete(.) Estimate completion date A.Tk. ditch, A.Tk. gun pillboxes and all defended localities to stage one fire trench and crawl C.T's. by 27/5, assuming arrival of four Excavators on 18/5 your E42 of 15 refers.

APPENDIX "C."

PROGRAMME OF R.E. WORK FOR IMPROVEMENT OF DEFENCES.

(*a*) From : O.C. X Fd. Coy. R.E.
To : C.R.E. Y Division.
Progress Report for week ending 15.9.40.
Troops employed : 2 Secs. X Fd. Coy. R.E.
200 Infantry
5 3-ton lorries } Supplied by Z Brigade.

Note: 1 Sec. X Fd. Coy. R.E. in reserve employed on miscellaneous services required by Z Brigade.
Work started 17.8.40.

Description of Work.	Completed.	In hand.	Total projected.	Remarks.
Bren emplacement, Type A	10	4	25	
A.Tk. gun ,, ,, B	6	3	16	
Trench shelters, ,, C	20	5	40	
Bn. H.Q. dugout	–	1	1	

Expected date of completion: 31.10.40.

(*b*) From: Y Division.
To: 2 Corps.
Progress Report for week ending 15.9.40.
Troops employed: Divisional Engineers less approximately 3 Sections who are fully employed on other works ordered by Divisional Commander.

Description of Work.	Programme.	Percentage Progress.	Remarks.
Bren emplacement, Type A	100	50%	
A.Tk. gun ,, ,, B	50	40%	

Expected date of completion: 15.10.40.

APPENDIX "D."

In the case of the construction of a bridge, progress in message form from Field Coy. Commander to C.R.E. might be on the following lines:—

> Class 24 Bridge at HORSEFERRY(.) Three out of three trestle bays near bank complete(.) All pontoon equipment off-loaded(.) Two trestle bays far bank, 4 pontoon rafts started(.) Near approach 200 out of 300 yds. complete(.) Far approach 100 out of 200 yds. complete(.) Expect completion 1830 hrs.
>
> T.O.R. 1430 hrs.

The progress would be reported to higher formations by the General Staff in the following form, which assumes that the bridges have been lettered in the orders, copies of which have been sent back:—

> Expect completion of bridges as follows(.) Class 24 A 1830 hrs. D 1730 hrs(.) Class 9 B 1530 hrs., C 1730 hrs(.) C delayed by change of site imposed by enemy action.
>
> T.O.R. 1515 hrs.

THE ELEMENTS OF HILL ROAD MAKING.

By MAJOR L. F. R. KENYON, R.E.

I

THERE are few theatres of operations which do not present the engineer with road making problems. In semi-developed countries the tempo of operations is often governed by the speed with which communications can be constructed. Should the present war produce campaigns in comparatively undeveloped regions, it is certain that the engineers will be faced with the necessity for aligning and supervising the construction of roads, some of which will have to pass through hilly country.

There are many good books of reference to guide the military engineer with little or no previous experience of hill road making. But the trouble about any really good book of reference is that it is bound to contain a mass of detail. For this reason, it is sometimes difficult to extract the fundamental rules from these books. Provided these rules are thoroughly understood, the construction of a hill road is almost entirely a matter of common sense. Few calculations are necessary, as the books of reference provide tables from which all detail can be extracted.

The object of this article is to simplify the whole problem, by reducing the subject from its technical status to one of general common sense and judgment.

II

The problems involved in making a hill road can be sub-divided into a few broad sub-headings.

As soon as decision has been made to build a road from A to B, the engineer must select the alignment. The next logical step is the excavation and preparation of the formation. Next comes the problem of cross-drainage. This leads to the problem of culverts, bridges and retaining walls. The road is now ready for its soling, metalling, and consolidation.

Concurrently with the above five main problems, the engineer must consider the provision of the necessary stores, and the administrative points which will arise during construction.

The problem as a whole has therefore a comparatively small

family of seven offsprings. Each child has its peculiar characteristics to be considered later, but, fortunately, of the seven brats, six are males, in that they are logical and are not capricious. The administrative problem only is subject to no laws.

III

The alignment is probably the most engaging and fascinating part of the work. Before starting, certain information must be collected from "higher authority." It is reasonable to assume that instructions will define that the road will start from a certain place and should fetch up at some other. Besides this, a firm ruling must be obtained if it is essential that the road shall pass close to, or through any intermediate points; or shall, for tactical or other reasons avoid other points. The engineer must also know the traffic the road is to take, in order to be clear as to what ruling gradient is necessary. The width of the road, together with its berms and side drains, must be decided. Finally, it must be determined to what extent temporary interruptions will be acceptable to traffic running on the finished road.

The engineer is now clear to go ahead on his own, but he would be wise to inform his military commander that the process of alignment must be considered as a whole, and that if work is started on a preliminary line from the near end of the road, such work may be wasted, as an unforeseen hazard may lead to a realignment.

The next stage is to determine whether the country through which the road will pass imposes on the engineer the need for tying his alignment to one or more intermediate points. Such points might be obligatory if there is only one pass through a high ridge, or if there is only one suitable crossing over a river or ravine. In a road twenty to thirty miles long, it is common to find at least three or four such points. They can sometimes be spotted off a map, if one exists. A flight over the country may be a very great help.

Military and geographical conditions will therefore block out the general alignment of the road, and the next task is to decide with some exactitude the line of the road between obligatory points. Here again, the first thing to do is to consult the military commander about any tactical considerations which may affect the detailed alignment. A road through semi-developed country may well be subject to sniping, and it may be necessary to piquet the road whenever it is used. The piqueting problem may be greatly affected according to which side of a spur is selected for the final alignment.

The engineer is thus once more clear to tackle his own problems. A general look at the country will show up any major disadvantages or hazards on the alternative lines possible. A lose shale slope, with

the shale lying at its maximum natural slope, is to be avoided; initial construction will be difficult, since the more that is cut away the more comes down from above. Even when constructed, more stuff will come down across the road with every storm. A heavy rock cutting is another hazard worth avoiding, if this is possible without unduly lengthening the road. Other things being equal, the line which needs the least cross-drainage, and the fewest retaining walls will probably be the best. Finally, it must be borne in mind that the straighter the road, the better will it be for traffic, and the fewer will be the maintenance problems.

After running over the above general points, the engineer is clear to start the actual detailed alignment. The main fascination in hill road alignment lies in the fact that whereas the crow can fly from point to point in say a mile, the engineer may have to find a means of laying down a road five miles long, in order to satisfy his ruling gradient.

Of the various pocket clinometers used, the De Lisle level is one of the most convenient for this stage. This is known in India as the "Dry Level," not because it is dry—which it is—but because of the idiosyncrasies of the interior of the Indian mouth. It is dry in that it has no elusive bubble to chase; when once set, it depends only on gravity to retain its position. All that is required for the alignment party is the engineer with an assistant about his own height (or a stick with a cross piece set at the height of his eye), and two or three dogs bodies to set up small piles of stones, and whitewash them. If the hillside is covered with scrub, a few extras are wanted for clearing.

In running preliminary lines with the De Lisle level, it is as well to set the level to a slope slightly less steep than that to which the road must, according to its ruling gradient, ultimately run. The centre line of the road will be somewhat shorter than the line along the surface of the hillside. An allowance for easing the gradient at corners, and at the approaches to any bridges is necessary. And human nature must be countered; the engineer searching for his extra miles is liable to credit himself with the odd foot or two throughout his work on alignment.

In using this level, the engineer and his assistant should leap-frog; a series of alternate forward and backward shots will take up any minor errors in the adjustment of the instrument.

Preliminary lines can be run in this way at a rate, on a fairly clear hillside, of about six miles a day. If two or three alignment parties are set to work, it is a quick business deciding on the various alternative lines connecting obligatory points on the road. It will then be up to the senior engineer to decide finally on the alignment. To enable him to make the best choice, he must use judgment balancing such factors as to whether it is best to add to the l

of the road, or to take in a bit of rock cutting; whether to go for a minor bridge to avoid a detour; and finally, whether the geographical conditions justify him in returning to the military commander for a relaxation in the military conditions affecting the alignment.

The final decision is then taken. If time permits, the preliminary alignment selected should be checked with a more accurate level. In any case, the alignment of the road at the right level should be marked out on the hillside with pegs, protected by little piles of white-washed stones at about fifty-yard intervals. The further detailed work will now fall more logically under the next heading, which is the excavation and preparation of the formation.

The above sounds very easy, and it is really not very difficult. But snags do arise. For instance, there will be stretches along which no man can move without ropes (or wings). But for the main lengths the alignment can be accurately marked out as indicated, and checks can be found to ensure that inaccessibility of short stretches will not throw out the validity of the rest of the work.

IV

The excavation of the "Formation" is the next stage. It is best whenever possible to connect up the pegs marking the selected alignment with a trace two or three feet wide. This work should be done either with technical labour, or under close supervision. There will of course be gaps in this trace, for instance where the road will require culverts or bridges. But it will serve as an invaluable guide for the mass work of excavation which comes next.

There are certain general rules to follow as excavation proceeds. The alignment should be elaborated into a series of "straights" connected by properly laid out curves; the straights should join the curves at tangent points. The curves should be as easy as possible. The surface at curves should be properly banked. Provision at curves should be made for the maximum possible visibility round the curves. The detail of the work required at a curve is given in an appendix (see page 42). It will considerably assist traffic if the whole curve, with a stretch of road about twenty yards long on the lower end, and thirty yards long on the upper end, are on the level. This is a council of perfection, and if it cannot be followed, it is best to give a level stretch at the upper end of the curve, so that ascending traffic can get a run at the next straight length of the road.

The width of the formation will depend on what is laid down by superior authority. For a twelve-foot width of consolidated roadway, it is usual to provide for two four-foot berms, and provision must always be made for side drainage. If the road is in "side cut," only one—on the inside edge of the road—will be required. If the policy

is to build a very narrow road, provision must be made for passing places, and for space for stacking road metal.

As excavation proceeds, care should be taken that the final surface on which the soling is to rest should be cut to the right section. If too much is cut out, filling will be necessary, and later on the soling and metalling will subside where it passes over filling. The formation should therefore be finished to conform to templates cut to the correct camber in straight runs. At curves, the initial cut should be at the correct angle of banking.

In setting the final alignment close to major or minor bridges, much trouble both to the engineer and to traffic is saved if a straight run is allowed at each end of each bridge.

Should "Irish" bridges be contemplated, the vertical curves need watching. Nothing is more irritating than an Irish Bridge with a violent dip at each end, necessitating a reduction in speed to about five miles an hour. In many hill roads, no water passes over Irish Bridges for about three hundred and sixty days in the year, and it should be possible for all traffic to pass over these dips at their normal running speed.

If the road runs across gently undulating country, it is frequently worth while reducing the formation to level by a series of small cuts and embankments. It is very inconvenient for traffic when on such country to be unable to determine on a straight run whether on-coming single vehicles are hidden in one or other of a series of dips. In working out the necessary fill for an embankment, allowance must be made for settlement.

Linked closely to the work on the formation is the design and placing of retaining walls. These are generally needed to ease corners, or eliminate them; or to carry the road at the right level over a stretch of hillside of concave section. In judging the place for a retaining wall, it is necessary to balance the advantage gained in straightening the road against the height of wall required.

V

The next main problem to be considered is that of cross-drainage. Any hill road will cut across the natural run-off of storm water, and full provision must be made for passing this water under (or, in the case of Irish bridges, over) the road. In many countries, rainfall is limited to very short periods each year, and if the road is constructed during a dry period, the engineer may be tempted to under-insure. There is fortunately an absolutely certain way of assessing cross-drainage requirements.

When once the alignment of the road is decided, the engineer should block off the road according to the catchment areas lying

above it, from which storm water will run off. No matter whether a block is one square mile, or one hundred, the necessary allowance for cross-drainage must be made. The storm water runs off naturally in gullies, ravines, or in river beds, and so far as possible the cross-drainage should conform to such natural features. But in designing a culvert for a particular gully, the first consideration is the catchment area covered by the gully where it crosses the road, and not the cross-section of the gully at that point.

Any reputable reference book on road construction will contain a table showing the cross-section of the waterway required in varying types of country for different catchment areas. This cross-section will, for culverts, generally govern the span.

The calculations on which the span and height of a major or minor bridge depend are not so simple. In some cases, a little calculation is required. For instance, the water may run in a ravine a hundred feet deep and eighty feet wide; and it may be possible to verify that the maximum high flood level is about forty feet. But for many bridges it is essential to run through a series of calculations to arrive with certitude at the right answer. Here again any reputable reference book will indicate the points to be calculated, and the methods. In general, it is worth while first assessing the catchment area, and taking off from a table the minimum cross-section of waterway required. If the stream is not to be constricted at the bridge site, the minimum height of the underside of the bridge can be worked out. Some two to four feet extra height is allowed for the passage of trees and so forth which may come down in a storm. The first cross-check consists in comparing the result obtained with local evidence as to the maximum high flood level. For a small minor bridge, these steps may be enough.

It then is necessary to determine the theoretical depth to which foundations should go. Many hill rivers have moving beds going down many feet. Apart from this, the effects of scour must be considered. Again it is necessary to go to the reference book, and to work through the stages laid down. The theoretical results so obtained should again be tried against local conditions, tested out by trial excavations. Such tests will not give a sure guide against scour, unless rock is found, and the engineer who economizes over the depth of his foundations as required theoretically, does so at his peril.

Should it be necessary or economical to constrict the normal flow at bridge site, close theoretical calculation is essential. Such constriction may necessitate a bigger cross-section for waterway than is required to meet the straight needs for run-off of storm water, taken from a table. It will certainly increase the scour effect. In general, unless the engineer has considerable experience, he is advised to avoid any unnecessary constriction of the normal water-

way; where constriction is essential, very careful calculations must be made.

These calculations will, for bridges, give the depth to which foundations should go. For culverts and retaining walls the foundation depth is a matter of trial. The engineer should insist on a proper technical inspection of the excavation before any concrete or masonry is started.

The construction of Irish bridges over big river beds is a matter for very close attention. The bridge should run level across the bed of the river, and the surface must be neither too high nor too low. If too high, a very big scour will be set up downstream of the bridge; if too low, the surface will be silted over. The correct level should be found by taking a longitudinal section of the river some two or three hundred yards up and down stream. From this, the right level at the point of crossing can be deduced.

The usual waterway calculation is made, and the length of the approach ramps will emerge. The approach ramps should not be made too steep, as they may be wet at times; about 1 in 20 is a good rule, though 1 in 15 is permissible.

The constituent elements of a big Irish bridge—apart from training and protection works—are three; the roadway, the upstream wall, and the downstream wall. Here again, guidance is available in any good reference book. It will be found that the upstream wall will be considerably less than the downstream. This is due to the fact that every Irish bridge sets up a perfectly diabolical scour on the downstream side; so much so, that no such bridge is safe unless protected on the downstream side by a generous scale of boulder "sausages." These consist of large boulders, contained in nets of big gauge wire, something like Army Track, but with a larger mesh. These sausages should not be tied in any way to the downstream wall of the Irish bridge. They will shift after each storm, and if tied to the wall will take that with them. As they shift, in course of time, a further layer of sausages will be necessary.

Finally, the edges of the bridge should be marked by upright rails. These serve two purposes. First, they help traffic to keep on the bridge, when it is covered with shallow flowing water. Second, they indicate to prospective bathers how deep the water is running. They should therefore bear markings to show divers shivering on the brink exactly what they are in for.

Before quitting the subject of cross-drainage, in so far as it includes construction, a few practical points are worth considering. In military road construction, it is best always to go for the most simple design for culverts, retaining walls and abutments. Always inspect carefully the foundation excavation, and the bed showing at the bottom, before allowing construction to proceed. So far as possible, watch concrete into cement, particularly if the work is

being done by contract. Be very careful about the sand used in concrete, particularly if the work is in country with a meagre rainfall. Watch dry stone work, course by course if possible, and insist on a decent guage of stone, with plenty of bondstones.

In this connection, the writer had an amusing experience. A certain wall hung fire for a period of months; the wall was some way from a good source of stone, and the work was being done by contract. No pressure secured an advance of work. A brief absence connected with a promotion examination produced the most startling achievement. After three days' absence, the wall was absolutely complete. The contractor greeted the writer on his return with the great news, coupled with a request for immediate payment. This time, pressure was resisted from the other side. This was fortunate, since within a week the face of the wall developed a most delicate convex bulge. In a fortnight, all was over, and this in the absence of any rain to lubricate and accelerate matters. If a dry stone wall is, on the other hand, properly constructed it is absolutely safe to stand for ever. It is, however, not a bad plan, if it is on the high side, to introduce belts of a couple of courses in lime mortar every six feet. If good bondstones are not available, these can be made by running concrete into gaps left here and there in each course.

The cross-drainage problem covers not only the passage of water over or under the road, but also its control before it reaches the line of the road.

The simplest control is the side drain. This collects the water off the road itself, and also such water as falls between the road and any other control drains running higher up the hillside. Side drains discharge either away from the road, or through minor culverts placed at suitable intervals.

The next simplest control is that provided on a hillside above a road running in side cut. It is obviously undesirable to have the full run-off pouring down the hill, over the top edge of the side cut, into the side drain. To avoid this, drains are cut to a V-shaped plan, the lower point of the V discharging into a culvert. The practical point to watch here, is that the grade of the drain should be regular. If it starts steep, and becomes less steep, there will always be a spill over at the point where the gradient decreases.

The cross-sections of the above drains may vary. The normal side drain is about two feet wide and two feet deep. The upper protection drains vary according to the catchment area above them. Drains three feet wide at the top, two feet wide at the bottom, and two foot six deep are usually adequate.

The next control is that imposed upstream of a bridge. This subject is a big one, but in most cases a problem can best be solved by a maximum of horse sense and a minimum of theory. The writer heard one evening three theories produced about training

works. One was to put in works to edge the water through the gap under the bridge—*i.e.* by a wall running slanting downstream. The next was to run the wall straight out, at a suitable distance upstream, and thereby produce a cushion of still water at each end of the bridge. The third was to run a wall pointing at 45 degrees upstream, taking off from the bank just above the bridge abutment. The theory here was that a good deposit of silt would collect above the wall, and form a very deep protection upstream. As luck would have it, the first theorist fairly soon after dropped one of his bridges, because he diverted the full force of the stream on to one of his piers. The third lost one of his bridges, because his wall broke close to the bank, and then concentrated a mass of water against his abutment. The second was lucky, since his wall went west straight away, and his bridge stood for ever after without any training work at all.

What is required is a form of control which will ensure that the water gets an absolutely straight run under the bridge. The training works should be placed to this end in accordance with the local geography found near the bridge site, care being taken to avoid work which may set up eddies and scours near the bridge.

VI

The work so far described will produce a properly shaped formation running in a series of straights and curves, protected from the run-off from storm water, with retaining walls to help it round corners and awkward places, and with bridges and culverts allowing for the passage of water falling on catchment areas above the line of the road. It remains to give some detail on the preparation of the final road surface.

This may vary from a mere dust track, through the stages of a shingle road, to be consolidated by the traffic running over it, to a properly finished water or oil-bound road.

A good general idea of what is required is gained by a short description of the preparation of a water-bound surface.

The first stage is the provision of a foundation on which to lay the metalling. This is given by soling. The soling should consist of hand packed boulders, and the thickness of this layer of soling should be nine inches. The soling should extend one foot outside the metalling—*i.e.* if the metalling is to be twelve foot wide, the soling should be fourteen foot wide. Particular care sould be taken in packing the edges of the soling, and these should if possible be keyed into the formation. Extra strength will be given if a series of diagonals are laid along between these edges and the triangles so left filled in last. After careful inspection, earth should be worked in between the boulders, and a thin layer of earth should be laid over the soling. This layer should only be just sufficient to spread the

weight of the roller used in the next stage. Before proceeding to metalling, the soling so produced should be rolled with a heavy roller.

It will be remembered that the camber and banking was allowed for in the last stage of preparing the formation.

During the soling stage, the difficulty is usually to obtain sufficiently large stones. During the metalling stage there is a double difficulty. The metal should be obtained from decent sized boulders, and should be broken down, so that each stone will pass through a two-inch guage. While the breaking is in progress, save up all the chippings, and when the metal is ready, have it screened and save up any more small stuff collected.

The metal should now be spread six inches deep, and as it is being spread, roll in. A little water should be used during this stage. Care must be taken that the camber is maintained during the rolling. In due course, a tightly packed, fairly dry surface will be produced. The chippings and screenings saved from the stone breaking process should now be spread over the surface, and the whole should be well watered and rolled. It is often found that the chippings are not really sufficient to bind the metal together, and something extra is called for. Do not be drawn into using earth. This will produce at once a nice looking surface, which after a few days' running will break up. The best stuff is fine shingle from dry river beds—say one-eighth to one-quarter inch guage. The surface so produced will still be delicate, and will be worth some additional protection. Again, this should not be afforded by earth. A thin layer of damp sand is best. If it is possible to keep the surface a little wet for the first week's use, so much the better. The six inches of metal, with chippings and everything else will be consolidated down to a four and a half inch layer.

If the road is to be handed over really complete to maintenance engineers, it should be properly marked out. This involves mile and furlong stones, and the numbering of all walls, culverts and bridges. Warning signs should also be put up.

VII

There are now left two of the progeny, stores and administration. These two are not directly concerned with the field engineering part of hill road construction, the main concern of this article. No Field Engineer would be wise to rely on comparatively uninstructed personnel, possibly not in close touch with the work, for all matters concerned with stores and administration—even if he is allowed to.

The stores question is quite straightforward, even if tedious. The main point is to get back as early as possible a preliminary bulk estimate of what will be wanted. Such an estimate can certainly be

produced as soon as the alignment is settled, and the elements of the cross-drainage problem solved. Many items can probably be dealt with even earlier.

In general, it is a case of giving those in rear the clearest description of what will be wanted, and of giving this description as early as possible.

VIII

The administrative problem is liable to be capricious. The Field Engineer is primarily concerned with the type of labour to be employed. The use of a Field Company is of inestimable value. The difficult jobs, and those requiring close supervision can be turned over out of hand. Troop labour is satisfactory only if a proportion of the troops are technical. For instance, two or three battalions can be worked efficiently, if a Field Company is available both for the above mentioned difficult jobs and also for close co-operation at all " levels " with non-technical troops.

If local labour is to be used, decisions are needed when to use " direct " labour—that is labour working directly under a hierarchy, of which the Field Engineer is the apex—or contract labour, in which case jobs are parcelled out, and are paid for according to the results or according to the terms of the various contracts.

Examples of work suitable to different classes of labour are given below.

A Field Company.	Cutting the initial trace for the formation. Constructing concrete slabs for culverts. Launching members of minor bridges (*i.e.*, up to 120-foot span).
Troop Labour.	Main formation cutting. Soling. Collection of material for soling and construction.
Contract Labour, working to a measurement contract.	Excavation. Soling. Retaining walls, culvert and bridge abutments. Preparation of metalling.
Direct Labour.	Consolidation.
High Class Contract Labour.	Major Bridges.

Depending on the class of labour to be used, administrative problems will develop. Daily labour will require accommodation, if the country is undeveloped. If the labour comes from a backward race, hygiene must be considered. In any case medical requirements must be met.

It is not intended to complicate this article with a list of administrative horrors which may arrive to retard work. But as with stores, if he wishes the work to proceed smoothly, the Field Engineer must keep a weather eye open on predictable administrative crises, and get his demands in as early as possible.

IX

From what has been written above, it can be deduced that the construction of a hill road is not a highly technical operation. The real art consists in keeping everything as easy as possible, not only for the perspiring Field Engineer, but for everyone else. If the clever Field Engineer can himself spare the time to produce complicated and ingenious designs, he will be lucky if he can be certain that they will be understood by his hierarchy of subordinates. His time will be full if he can keep design ahead of execution (not always the case), get round all the outdoor work every day, spot and rectify matters which if unattended will hold up later jobs or lag behind the general tempo, and last but not least, keep everyone reasonably contented, as well as efficient.

APPENDIX.

ROADS—LAYOUT OF CURVES.

Object.

1. To reduce as much as possible the danger and hindrance imposed on traffic by corners.

Main Factors.

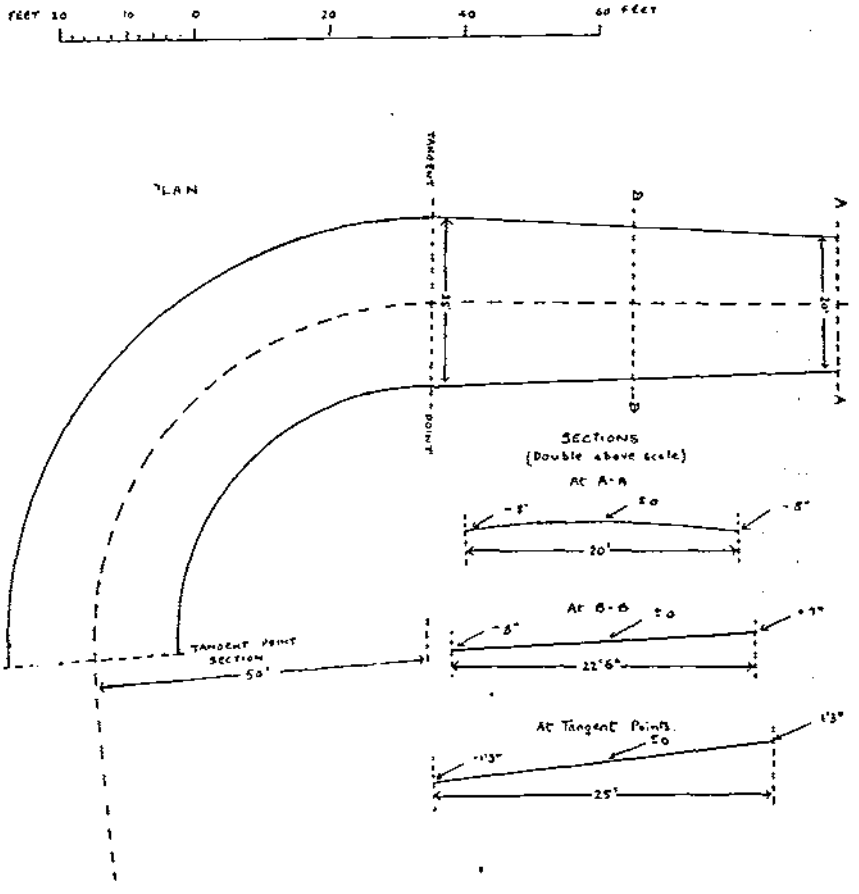
2. These are that gradient should be the minimum possible, that alignment should be the best possible, that correct banking should be provided, that drivers get the longest possible view round the corner, and that warning signs are provided.

Sequence of Work.

3. Set out the alignment of the road. The centre line should consist of a series of "straights" connected at tangent points with properly laid out curves. A circular curve is the easiest to lay out, and is satisfactory for all normal traffic.

4. (*a*) The layout for each curve includes a stretch of road 60 feet long outside each tangent point. Taking a road with 12 feet of consolidated roadway, and 4 feet berms, width at sections A–A will be 20 feet, at Sections B–B, 22 ft. 6 in., at Tangent Points 25 feet.

DIAGRAM ILLUSTRATING LAY OUT OF A CURVE



(*b*) Mark out on the ground points on both edges, and on centre line of road at Sections A–A, B–B, and at Tangent Points.

(*c*) Join up the three lines denoting the two edges and the centre of the road by tape or by spitlocking.

(*d*) The curved portion of the road should be marked by calculating offsets, or by tracing out direct from the centre of the circle on the circumference of which the road will run.

(*e*) The road will by now be fully laid out in plan. Before proceeding, check that the full width of soling (14 feet in this case) will, if possible, lie on solid, as opposed to made, ground.

5. Taking the simplest case (*i.e.* when the road runs level throughout the whole job), assume the centre point of the road at road surface level at sections A–A to be ± 0, work out reduced levels at the edges

of the road at sections A–A, B–B, and at Tangent Points. With the road running level, the centre line will run level throughout the job.

6. The road should be in full super-elevation from tangent point to tangent point. The banking allowed depends on the radius of the curve, and the normal running speed of the traffic. An average allowance is :—

Radius of curve	35ft.	50ft.	100ft.
Banking, 1 in	7	10	15

7. Taking a curve with radius 50 feet, the reduced levels will be :—

	Centre line.	High edge.	Low edge.	
Section A–A ...	0	−8 in.	−8 in.	(ignoring
Section B–B ...	0	+7 in.	−8 in.	fractions
Tangent Point ...	0	+1 ft. 3 in.	−1ft. 3 in.	of inches)

8. Take levels on the ground, and mark on pegs the cut or fill required at each section on the edges and centre line of the road. Insert pegs in their correct places.

9. Mark up and insert similar pegs at about 10 feet intervals round the curve.

10. The layout is now complete. Close supervision is required in excavation until a 4 foot wide trace has been cut (or filled) to the correct level longitudinally throughout the job, and transversely across section at A–A, B–B, and at Tangent Points. Thereafter, ensure by the use of straight edges that even surfaces are obtained both along and across the road, between the points for which levels have been calculated.

REINFORCED PORTLAND CEMENT CONCRETE IN COLD WEATHER.

By RUSSELL V. ALLIN, M.INST.C.E. *and* H. H. TURNER, A.M.I.CHEM.E.

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MOST of the information available on the effect of frost on fresh concrete is intended for application in more severe climates than that of the United Kingdom. Some important facts have been established by research, viz.,

(1) Concrete attacked by frost before it has set will eventually

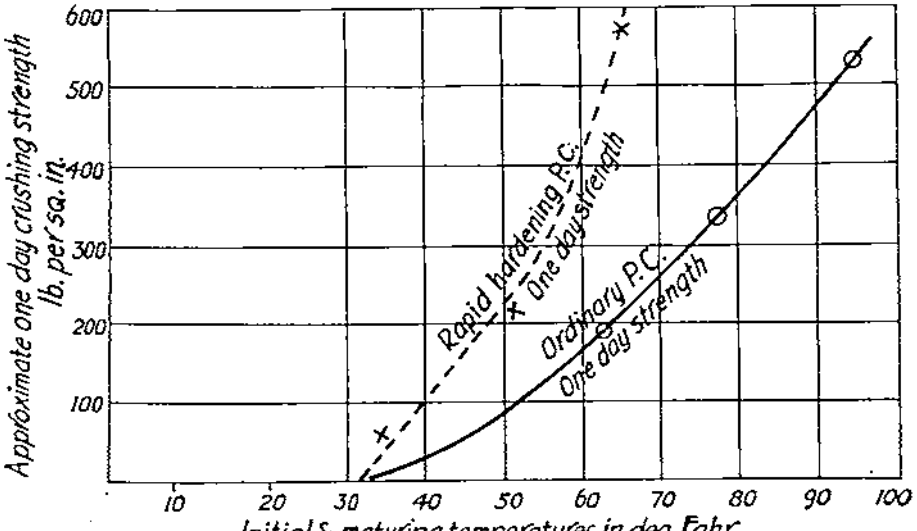

FIG. 1.

harden but loses up to about 50 per cent of its strength and modulus of elasticity, depending on the degree to which it has been frozen and the water-cement ratio employed. The portions affected also have a greatly increased porosity.

(2) The richness of the mix does not substantially affect the resistance of *fresh* concrete to freezing.

(3) The temperature of the concrete when placed and matured has a great effect on its early strength (Fig. 1).

(4) The rate of rise of the temperature of hydration is greatest

between six and twelve hours after mixing and is accelerated by pre-heating the concrete. This has an important influence on its resistance to freezing.

(5) High-alumina cement concrete is more resistant to frost than Portland cement concrete owing to its more rapid generation of heat during setting.

(6) Heating the mixing water as a precautionary measure against frost has no deleterious effect on the strength of concrete up to a temperature of about 200°F.

(7) Alternate freezing and thawing of concrete when immature may cause severe damage.

(8) Wind has a great influence in freezing concrete.

(9) The protective effect of timber shuttering is equivalent to that of a layer of concrete of about five times its thickness.

(10) Owing to the large amount of heat generated while it is setting, mass concrete does not give rise to important difficulties.

Section 4 of the Code of Practice, which deals with work in cold weather, makes, *inter alia*, the following recommendations: "When depositing concrete at or near freezing temperatures, precautions shall be taken, to the satisfaction of the responsible supervisor, to ensure that the concrete shall have a temperature of at least 40°F. and that the temperature of the concrete shall be maintained above 32°F. until it has thoroughly hardened. When necessary, concrete materials shall be heated before mixing. Dependence shall not be placed on salt or other chemicals for the prevention of freezing."

The primary objects of the writers' experiments were to derive some approximate working rules for pre-heating, applicable to this climate, by which to ensure carrying out these requirements, and to confirm previous findings with regard to the extent of the damage caused by freezing.

EXPERIMENTS.

Two types of experiment were carried out. Type (*A*) cubes were wholly or partially frozen and subsequently crushed after various periods of maturing. Type (*B*) cubes were made at various temperatures by pre-heating the water only and subsequently exposed to conditions simulating those likely to occur when concreting in frosty weather. The crushing strength of these cubes was then ascertained at various ages. Cast steel moulds were used in preference to timber as, on account of their higher conductivity, the concrete was exposed to conditions which were considered more applicable to those in which most slabs are concreted. Slabs, it should be noted, are usually the members most vulnerable to attack, as they are not protected by shuttering. In addition, some field

tests were made upon concrete placed in cold weather followed by frost at night.

Results of Experiments.

With type (*A*) cubes the crushing tests fully confirmed the fact that concrete frozen before setting will harden to a large extent if undisturbed, but does incur permanent loss of strength. This loss may reach 50 per cent, depending on the degree to which it has been frozen and to a lesser extent on its water-cement ratio. In addition to this loss an increased porosity is noticeable. With type (*B*) cubes the graphs shown in Figs. 2, 3, and 4 are typical of a number of experiments made and illustrate the effect of the heat generated by setting in preventing frost attack. Figs. 2 and 3 are instances where the temperatures of the pre-heated water were adequate and prevented the concrete from freezing. In Fig. 2 the initial temperature of the concrete cube was 65°F. and that of the air when moulded 28°F. In Fig. 3 the corresponding temperatures were 52° and 35°.

Fig. 4 represents a case where the pre-heating temperature was too low to protect the cube from frost and the concrete was therefore partly frozen. The initial temperature of the cube was 45° and that of the air 26°. The ultimate strength in this case was about 70 per cent of its normal strength. In other experiments, in which cubes were completely frozen, as much as 50 per cent of the strength was lost. In all cases the top surfaces of the cubes were not covered throughout the experiment, and the air temperature was brought down to about 10° below freezing point within 18 hours after placing in the moulds.

Tests on Works.

Some idea of the effect of timber shuttering and protection of the fresh concrete in such a manner as to conserve its setting heat can be gained from the results of the following site observations which are typical of a number taken.

(1) Concrete at 44°F. was placed in a reinforced slab 16 in. thick at an air temperature of 34° and immediately covered with coconut matting, leaving a space of about 4 in. between it and the top of the slab. The average air temperature for the following 24 hours was about freezing point, but the surface of the slab did not fall below 38°, or 6° above the air outside the protective covering.

(2) Beams were poured with concrete at 47° in an air temperature of 39° between shutters and covered at the top with cement bags. The mean air temperature for the next 24 hours was 36°, but the concrete showed an internal temperature at the end of that time of 61° and a surface temperature of 40°, or 4° above that of the air outside the cement bags.

From the foregoing it is clear that the two points of primary importance in the prevention of attack by frost are, (1) Provision of heat in the concrete in the early stages of the work before it commences to set and generate its own heat, and (2) Its subsequent

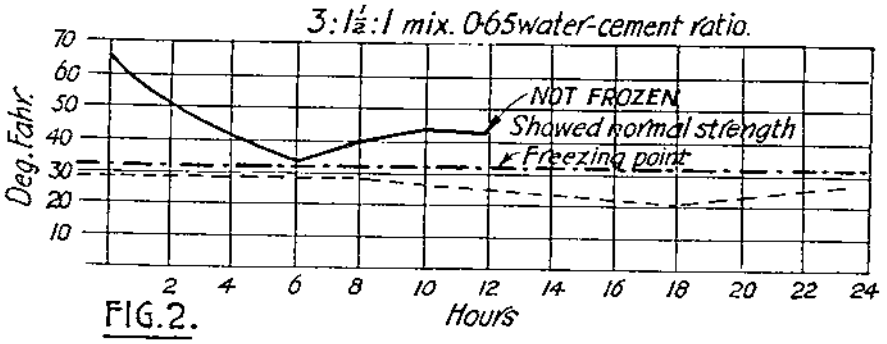

FIG. 2.

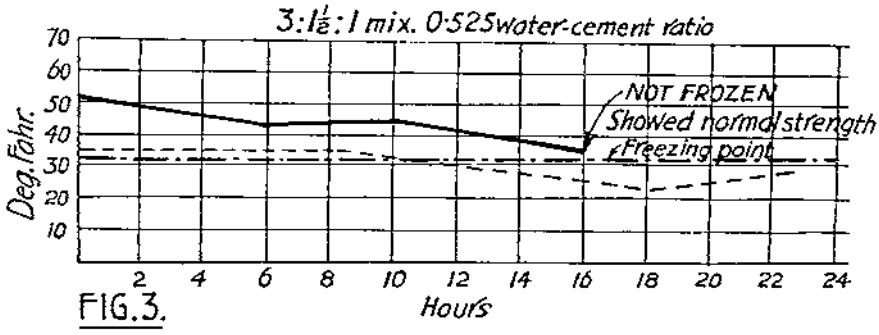

FIG. 3.

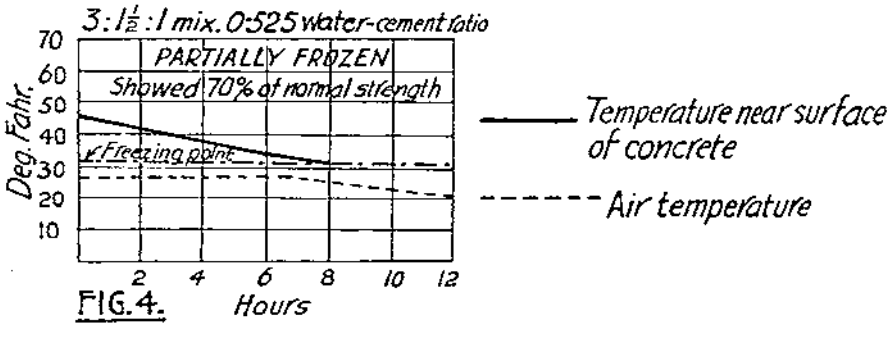

FIG. 4.

conservation by protection. It is essential therefore that it should be pre-heated at the mixer and protected as soon as possible after it has been placed.

The life of reinforced concrete depends chiefly on the preservation of its cover, which is the part usually most vulnerable to attack by frost. It is clear therefore that the concrete must be completely protected from freezing during construction.

PRE-HEATING.

Having regard to the possible effects of shrinkage and contraction by rapid cooling of pre-heated concrete, and also to the necessity of raising the water-cement ratio in order to preserve its workability, the writers are of the opinion that these temperatures should be restricted. Safety and economy can both be served by limiting them to such as can be attained by heating the mixing water *only*, provided that the aggregate is not frozen when it is put into the mixer.

From meteorological records taken in various parts of the country it has been found that, in normal years, an average of about 75 per cent of the delay due to the present custom of ceasing work at about 35°F. can be saved by continuing work until the thermometer drops to 30°. The writers' estimate from laboratory and site tests that, if the necessary measures are taken to protect the concrete as soon as possible after it has been placed, work can be conducted in accordance with the Code of Practice down to a temperature of 30°F. (followed by a night frost of not more than about 10° below freezing) by the method of pre-heating the mixing water *only*. This should commence when the air temperature has dropped to, say, 38°, when the concrete should be heated to about 50° at the banker. This will involve a water temperature at the mixer of about 100°F. Theoretically, for each degree drop in air temperature the water temperature should be raised about 18°, so that when the air temperature has dropped to 30° the water should enter the mixing drum at about 190° F.and the concrete at the banker should then be at about 65° (see Table I).

Temperatures in deg. Fahr.		
Air when concreting	*Mixing water*	*Resulting concrete*
38 to 35	100	50
34	118	53
33	136	56
32	154	59
31	172	62
30	190	65

Approximate temperatures of mixing water for pre-heating concrete

CONSERVATION OF HEAT.

All surfaces not covered with shuttering, such as slabs and construction joints, should be protected as the work proceeds. In the case of slabs this protection should be tarpaulins or similar materials, leaving an air space of a few inches between the covering and the surface of the fresh concrete. These coverings should be left for at least two days before removal, as alternate freezing and thawing of immature concrete may do it considerable damage. An extension of the mixing time, consistent with expedition in placing and provided the concrete is allowed to retain its workability, will assist resistance to attack by frost. The water-cement ratio should also be kept as low as possible. It should be noted that the temperature of concrete that is not pre-heated is, when it leaves the mixer, a few degrees higher than atmospheric temperature. In practice, the engineer will usually judge the temperature at which he considers it likely that the concreting will finish and heat the water to correspond with that temperature throughout the work.

In the table it has been assumed that steel shuttering will not be used; further, it must be understood that, owing to the differences of working conditions prevailing on different sites, the temperatures contained in the table are based on average conditions and must necessarily be of an approximate nature. The efficacy of these measures can, however, be readily checked by the use of thermometers. Concrete frozen before setting can be detected by its tendency to soften and show moisture when brought into contact with heat. No reference has been made to the employment of such precautions as heating the aggregate or electrical heating of the concrete, as there are certain objections to these measures, particularly in reinforced work, which, in the writers' opinion, do not justify their employment in the climate of this country.

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RIVER TRAINING WORKS

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(*Reprinted from the "Indian Forester," March*, 1940.)

WHEN rainfall and flooding are considered as affecting the Forest Department, the problem which immediately comes to the fore is: How to check the insidious and ever-increasing removal of the fertile soil from the hill slopes, which fertile soil is carried down at least to the plains, if not to the sea, leaving barren hillsides? This problem of widespread erosion is a matter for special study and for the attention of Governments, Central as well as Provincial, and is now receiving tardy recognition. There has been detailed investigation over some years and much data has been collected and published and I do not propose to deal with such problems here.

What the average Forest Officer very often has to consider, however, is some problem connected with river training. It may be, that a fast-flowing stream has to be controlled at certain points, or, as is more probable, that some river in an alluvial plain is eroding, especially at flood times. Any fast-flowing stream is to be found in the higher elevations where the harder strata are to be met with and a stream of this nature has, in course of time, carved out a definite deep bed for itself. Any river training consists in strengthening the bank at some point by means of a concrete or masonry wall, well bedded. The particular problem I propose to discuss is: What measures to take to control the course of a river in an alluvial plain?

In any alluvial area, a river never flows in a straight course for more than a very short stretch and not only meanders about its general bed but frequently alters the course of its general bed. The flow of water has a scouring action on the bottom and sides of the river bed. To start each class of material in motion, a certain velocity of the stream must be attained. While the normal flow of any stream will cause scour only at certain points in the bed, where, for some reason, there is a temporary increase in the velocity, yet at flood times, the increased flow causes scour to a varying degree.

Scouring takes place at the bends of a river and the action of the river flow at any bend can be considered. The two drawings, Figs. 1 and 2 in Plate 1, showing the plan and the sectional elevation of a river at a bend, will explain what takes place.

PLATE I.

RIVER TRAINING WORKS

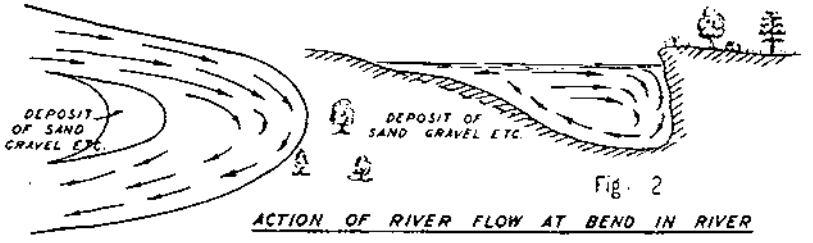


Fig. 1. Fig. 2

ACTION OF RIVER FLOW AT BEND IN RIVER

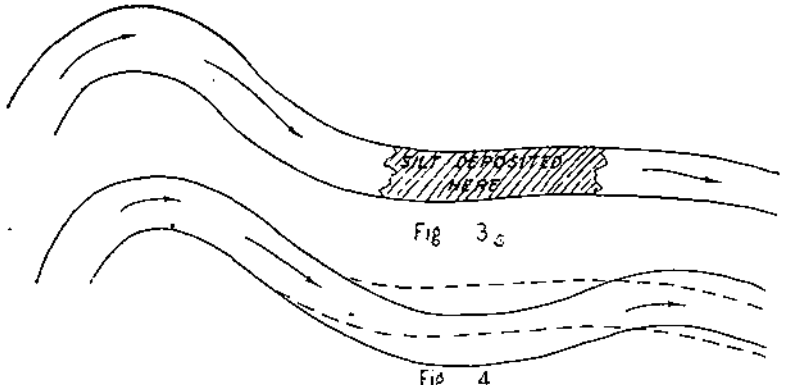
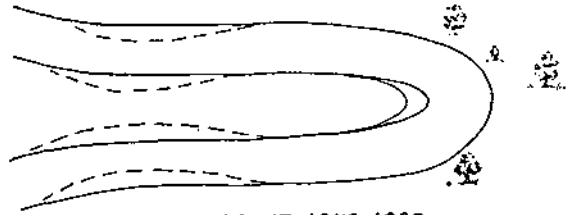


Fig 3

Fig 4

POSSIBLE ACTION OF RIVER AT STRAIGHT



PROBABLE ACTION OF RIVER AT LONG LOOP

Fig 5

At any bend, the centrifugal force causes an outward pressure which results in the level of the stream being highest *near the outer bank*. With any river flow, however, the velocity of the current is greatest on the surface and increases towards the centre of the current. At the lower-level stream flow, the river bed causes a reduction in the velocity and also in the centrifugal force. The higher level of the stream flow at the outside of the bend results in the water near the bottom at the outside of the bend flowing

inwards, carrying with it sand, gravel, etc., which is deposited at the inner bank. When the stream is in flood, the surface velocity is at its maximum near the outer bank and at its minimum near the inner bank and the increased velocity of the flow on the outer bank causes erosion.

No river in any alluvial area is ever stable and with the greatly varying discharge of the river there is a constant change of channel. The increased velocity at the bends results not only in erosion there but in the deepening of the channel. While at the bends the river is deeper, in most of the straights it is shallower. Any change of velocity from high to low in a stream carrying material in suspension must result in some portion of the material being deposited, with a consequent silting up of the channel. The drawings, Figs. 3 and 4 in Plate 1, show what often happens in the straights of an alluvial river. More and more silt tends to be deposited in the straights. Once the channel there becomes too shallow, the increase of flow in flood times will result in the river tending to strike out in a new channel. The old channel is shown with dotted lines. With the strata to be met with in any alluvial district, it is a comparatively easy matter for a river to cut into the banks, as any increase in velocity will remove most material met with.

A formation occasionally met with is a long loop. The drawing, Fig. 5 in Plate 1, gives an idea of the type of formation. The river may extend and extend the loop and then, when the neck of land is fairly narrow, the river decides to cut through the neck and take up a course, as shown by the dotted lines, until it cuts through completely. In any such case there is bound to be heavy erosion elsewhere, as a river flowing through soil of uniform density has a fairly constant length and, where any length is lost in one locality, such length has to be made up elsewhere.

Any river training works for main rivers is a work of magnitude far outside the scope of the Forest Department. Our problems consist either in protecting a bridge from serious erosion or in discouraging erosion in some area on which there are buildings or valuable forests to be protected.

For the most part, although an alluvial river may keep on changing its channel, its bed remains fairly constant, and the river meanders within certain limits. Thus satisfactory results can usually be obtained if steps are taken to *guide* the river rather than *obstruct* it.

Protection to the banks can be given by :

A.—Revetting and
B.—Guide Bunds.

While revetment of the banks, in conjunction either with guide bunds or some structure which induces silting or at least prevents erosion, usually produces satisfactory results, it is seldom that revet-

ment alone produces any lasting success. It has already been noted that the reduction in velocity of the stream flow results in the deposit of silt. What should be aimed at is to discourage the stream from eroding the bank at the danger point and to encourage the stream to deposit silt at such site.

Each class of material requires a certain velocity to start it in motion. The erosive power of water varies as the square of its velocity and its transporting power varies as the sixth power of the velocity. The table as given below shows the effect of velocities on various materials :

Material.	Bottom Velocities in Feet per Second at which—		
	Transportation begins.	Material is in equilibrium.	Deposition begins.
Coarse sand	1·00	·70	·60
Gravel—size of pea	·70	·60	·7
Gravel—size of small bean ...	1·60	1·00	·7
Shingle—rounded and one inch or more in diameter	3·2	2·2	1·6
Flints—size of hen's egg ...	4·00	3·20	2·20

It will be noted that with each class of material, while a certain velocity must be attained to set the material in motion, yet, once the material is in motion, the velocity can fall appreciably below this initial velocity before the material is again deposited.

While any revetment of the nature of a brick or stone masonry or concrete wall against a bank would withstand any stream flow so far as the face of the wall and the upper structure were concerned, the danger with such a structure lies in the foundations being undermined by erosion. Any interference with a stream flow tends to cause scour. Unless the nature of the river bank is such that any revetment wall can be built up on a good solid foundation, some other form of revetment is advisable. A more suitable material for revetment is, in most cases, readily available, namely, wooden piles. In river training works of any importance, these piles should be driven by a pile-driver.

Pile-driving is an operation with which most Forest Officers are conversant and there is no need for me to discuss the question of pile-driving here. What I would emphasize is, however, that any piles used in any protection works should be sufficiently large and of some durable species. If the work is of any importance then it is worth doing well and the piles used should be of some durable species dressed to heartwood rather than poles of some uncertain species, used by reason of the fact that they have no outside market value.

For supporting the bank, good piles from a strength point of view could be spaced at three feet or more apart. Where, however, they

have to be driven well down into an existing bank there are difficulties to be met. To have a proper backing to the revetment, the piles would have to be driven side by side, a lengthy and expensive undertaking, or a backing of heavy gauge corrugated iron sheeting can, where only silt has to be penetrated, be driven in behind the piles. In a protection work in Assam, I drove in 18-gauge corrugated iron sheets to a depth of about eight feet behind a row of piles at about two-feet centres. The driving of the corrugated iron sheets was done slowly by means of a light pile-driver, consisting of a wooden monkey working up and down in a frame made from two lengths of 24-lb. rail. To minimize buckling at the driven end of the corrugated iron sheet I had to clamp two pieces of wood along the edge and fit another length of wood between the monkey and the top of the sheet in order to distribute the blow more effectively along the edge. Too wide a space cannot be left between the piles, as the longitudinal section of the sheet has to take the pressure of the bank.

Where a protective wall can be built up and a backing given later, the construction of any revetment is greatly simplified. Piles can be driven, three feet apart or more, and cross battens or rails fixed between the piles, which will take the thrust of the corrugated iron sheets. The photographs clearly show the type of construction used.

With any revetment along an endangered bank, it is essential that protection be given to the foundations or foot of the revetment. In some cases definite obstruction is given by means of *spurs* but the alternative is not to obstruct the flow along the particular bank but to slow up the current. Such slowing up can be carried out by driving in small poles, three or more feet apart, in the stream bed near and above the threatened section of the bank. The arrangement of these small poles is shown in the photograph taken upstream from a forest tramway bridge which was threatened. These poles were driven by means of a light pile-driver of the type used for driving in the corrugated iron sheets. In some cases the poles could be driven by means of a heavy maul but such requires a strong man to wield it and such men are seldom available. It is very essential that the poles should be well driven in, as they have to withstand a strong current in flood time. A stronger and more satisfactory job is done if the poles are connected by plain galvanized wire. With such a construction there is less chance of any weak pole or poles being uprooted at the flood period when their presence in the stream bed is most necessary.

An important forest tramway bridge in Assam was continually being threatened and one or two bays had to be added owing to the cutting away of the southern bank. The plan, Fig. 6 (Plate 2) will best illustrate the protective works which had to be carried out and the photographs clearly show the excellent results achieved. The river concerned was the Hel River (for some time we considered the name was very apt) and like most rivers in the Goalpara District, it

PLATE 2.

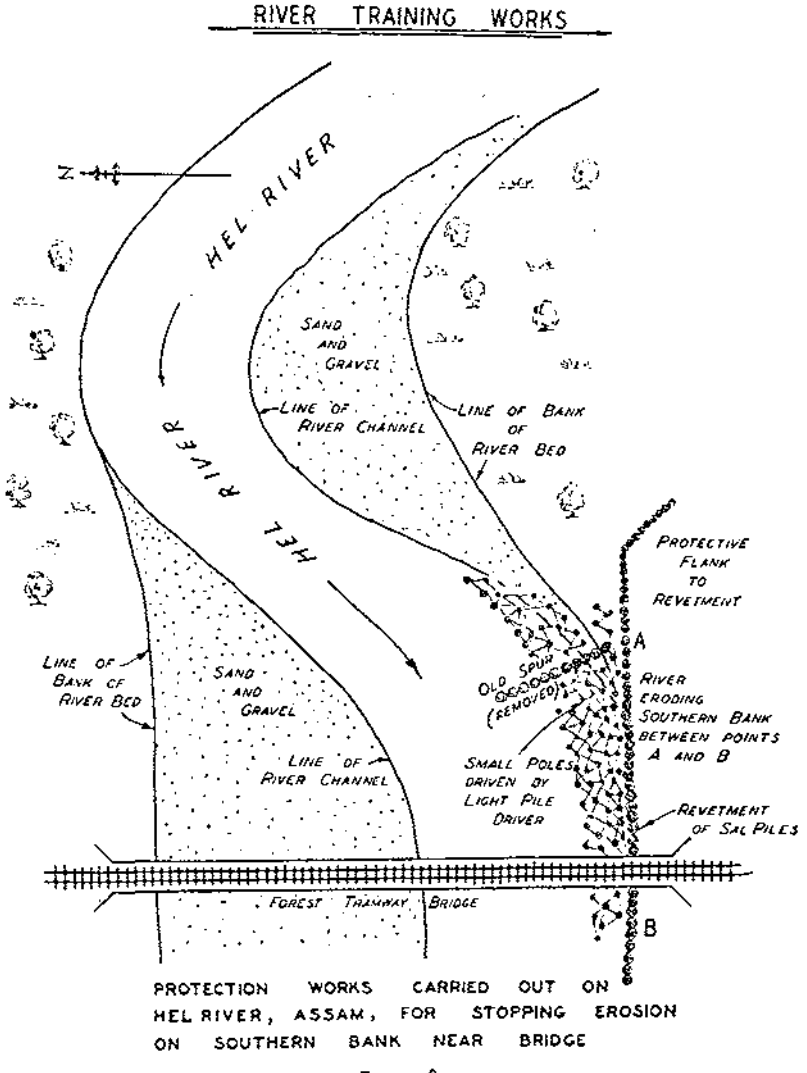


Fig. 6.

carried down a tremendous volume of water in flood time. Constant erosion was going on at and above the forest tramway bridge at the southern bank and various forms of protective revetment had been considered. A spur had been constructed of piles just above the bridge in an attempt to stop the erosion but by reason of such spur being at right angles to the stream flow, the spur had done rather more harm than good and there was accelerated scouring on the downstream side. Steps had to be taken to protect the southern bank

Photo No. 1.

Photo No. 2.—

Photo No. 3.—

River training works 1, 2, 3

Photo No. 4.—Photo taken from southern end of bridge showing initial stage of revetment works and light poles driven in the stream bed.

Photo No. 5.—Photo taken from the same spot about a year later.

Photo No. 6.—Photo taken from the same spot about two years after the first photo was taken.

River training works 4,5,6

from further erosion and to encourage silting at and above the threatened bridge. For the protection of the bank, piles were driven further apart and corrugated iron sheets driven in behind to support the high bank. At the foot of these piles "sausages" made from small boulders enclosed in wrappings of wire netting were laid. Such sausages minimize the scouring action of the water and as any sand, etc., is scoured out from below they settle down into place. For six to eight feet into the stream bed near the bridge small *sal* poles were driven by means of a light pile-driver. These were connected by galvanized wire. Farther up from the bridge these small poles were further extended into the stream bed as shown in the photographs, and the outer edge of these poles was laid in a curve such as it was hoped the flow of the stream would finally follow. The height of the small poles above the stream bed was only three to four feet and a lesser height would have sufficed. It is not desirable that these poles should project too high, otherwise floating debris would be apt to get caught and cause scouring. The deposit of silt takes place to the greatest extent during the subsidence of the flood water.

The three photographs 4 to 6, were taken each time from the same place on the southern end of the bridge, facing upstream, and show the very satisfactory results obtained. The second photograph was taken over a year after the first photograph (taken when the poles were first driven in), and the third photograph about two years later. The middle photograph shows the silting process at its intermediate stage. Had the excellent results with the small poles been visualized there would have been no need to extend the protective revetment of piles so far downstream. The last photograph shows this protective revetment with its flank extending well away from the final bank. However, at the time no chances could be taken and while, with the successful results with the "belt," the "braces" were not required, yet they might have been and nothing could have been done during the all-important flood time with the stream running full, bank to bank. For any further work of this nature reliance would be placed mainly on the fixing of the small poles to induce silting at the danger point.

Where there is undue scouring at the bend of a river, attempts have been made on occasion to reduce any such scouring action by cutting a channel across a bend with the intention of throwing the flow of the stream away from a threatened bank. An alluvial stream brings down a tremendous amount of silt during flood time and anyone who has observed any such stream or river in flood time will appreciate the rapidity with which a river can fill up one channel and cut out another. Cutting any such channel reduces the length of the stream. The channel has to be cut by manual labour and costs a great deal. While initially there may be a flow down such

a channel, it very soon silts up again and any such scheme, from my own personal observation but *not* experience, is not to be recommended.

We now come to the use of *spurs* or *bunds* built out into the stream. Such works are necessary on the larger rivers and are the subject of special study. Small spurs can usefully be employed by Forest Officers, however, and to obtain satisfactory results some of the general principles on their construction have to be understood. One too often finds instances where spurs or bunds have been erected into the stream at *right angles to the flow*. Such is about the *worst angle* which could be chosen for this sort of protection work. With stream flow of any extent, a bund or spur set out at right angles results in undue scour on the downstream side, resulting in heavy erosion of the bank and often destruction of the spur.

In all cases where spurs are employed the question of downstream eddies has to be given particular consideration and every measure taken to minimize such.

While, so far as I know, it has never been proved why such should be so, experience has shown that in the construction of any spur or series of spurs, the *best results are obtained with pointing the spurs upstream and with the downstream face of the spur making an angle of 30° with the direction of the stream flow*. Much, if not all, of the success in any scheme involving the use of spurs depends on the angle at which such are laid.

With several spurs laid round a threatened bend in a river, the angle at which each spur was laid would vary according to the flow. A series of spurs which I fixed in one river and which produced very good results were laid out somewhat as shown in the accompanying drawing, Fig. 7, Plate 3.

The drawings, Figs. 8 and 9 in Plate 3, show the plan and cross-sectional elevation of a type of spur which can be used either upstream or downstream and which can readily be fixed in most places. The spurs can be made of stout bamboos or of poles of *sal* or any other suitable species. Jungle-wood poles can be used if need be. The poles, if of timber, can be of three inches diameter upwards, according to supplies available and to the strain they may have to bear. What force they will have to contend with will also decide the distance apart they should be driven. The poles should be driven rather than handshaken into position and for any such driving a light pile-driver can readily be constructed. The normal distance apart is three feet. The spur starts well up the river bank and slopes down into the stream. The nose of the spur can be only a little above the stream bed. The poles are braced with plain wire and in between the two rows of poles should be filled in with brushwood. The spurs could be made reasonably impermeable by fitting a lining to the inside of the poles and filling up with sand, gravel,

etc., but, in my personal opinion, it is better to allow water to percolate through the spurs and such construction is cheaper and more readily maintained.

PLATE 3.

RIVER TRAINING WORKS

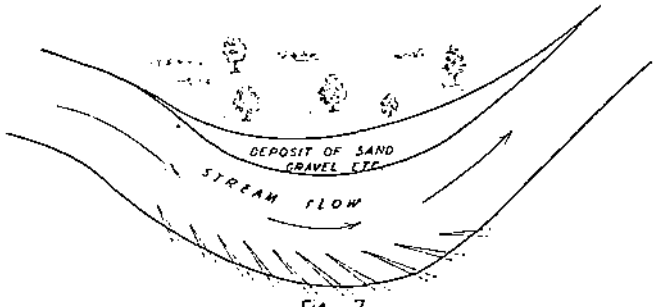


Fig. 7

USE OF SPURS TO COUNTERACT EROSION AT A BEND

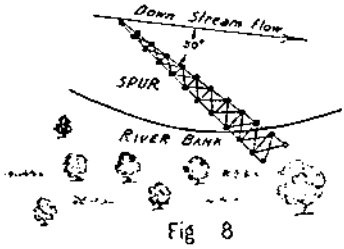


Fig 8

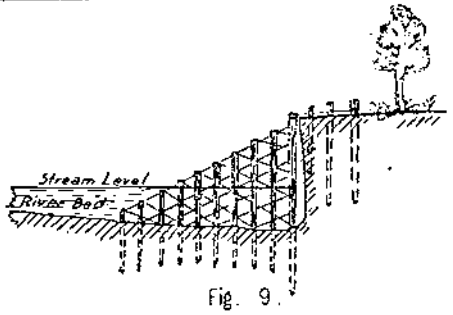


Fig. 9.

PLAN AND CROSS SECTIONAL ELEVATION UPSTREAM SPUR

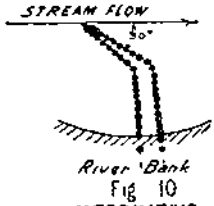


Fig 10

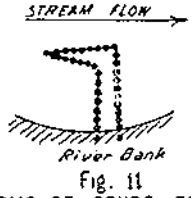


Fig. 11

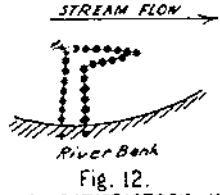


Fig. 12.

ALTERNATIVE FORMS OF SPURS FOUND SATISFACTORY IN SOME CASES

No hard-and-fast rule can be laid down as regards the *length* which spurs should be extended out into the stream bed. If some length is required as a guide, I would give a normal length of twenty-five feet. With a broad, normally slow flowing river the length could be increased but in the case of a narrower, faster flowing

river, the length would be reduced to twenty feet or less and the poles driven closer together.

Another point which arises is what the distance should be between each spur. The normal assumption is that a spur protects three times its own length of the downstream bank and, in favourable circumstances, may protect about five times its own length of the bank. Where a series of spurs are fixed, however, what has to be guarded against is that there are no eddies between any two spurs causing undue scour and resulting damage to either spur. In one case where spurs made from *sal* poles were successfully used, I had the spurs only fifty feet apart and less harm would result from having the spurs too close than too far apart. Moreover, as in the case of all river protection works, it has to be remembered that the danger period is during the flood period, when no driving of any poles in the stream bed is possible.

For more important works the Public Works Department have made use of spurs of the three types as shown in the drawings, Figs. 10, 11, and 12 in Plate 3, and the results have, in most cases, been very satisfactory. I have shown the construction as made with driven piles but such spurs have been made of concrete and stone masonry. The great advantage of piles, where such can be driven, is that any scour does not affect the foundations of any spur and in few cases will suitable timber piles not be available to our Department. From my own personal experience I have had very satisfactory results from the more simple type of spur as described and such is rather simpler to construct than the three alternative forms as shown.

MECHANIZATION OF R.E. UNITS FROM 1914 *TO* 1937.

Compiled from contributions and comments by various authors.

In a future volume of the *Corps History* will be found the story of the constant efforts of the Royal Engineers from early days to adapt available mechanical plant and transport to their work in war and in peace. It will show how, when war broke out in August, 1914, the R.E. had done a great deal towards giving the Army a mechanical transport service under the management of the R.A.S.C., but that the R.E. themselves had very little M.T. at their own disposal—in fact, the situation in this respect was as follows :—

There was no allotment of M.T. specially to R.E. for work with divisions, corps or army.

As regards R.E. units, a few Tillings-Stevens petrol-electric vehicles were available for mobile searchlights.

The Pontoon parks were still horse-drawn and no arrangements had been made to fit them for mechanical traction.

The Signals Service, which throughout the war was an R.E. responsibility, had a small number of light M.T. vehicles and some motor-cycles were allotted to Signal units. There was also the large body of motor-cycle despatch riders incorporated with the Signals.

But the R.E. field units had no M.T., not even motor-cycles, which would have been invaluable for officers and for R.E. intelligence, nor was it practicable at that date for the field units to give up their animal transport, because the motor vehicle of 1914 and for some years afterwards had a very low standard of cross-country capacity on account of solid rubber or high pressure pneumatic tyres.

The invention of track vehicles, although it made the tanks possible, did not commend itself for use on vehicles generally owing to inherent disadvantages of the track.

It was the development of the six-wheel vehicle in 1925 with its remarkable cross-country capacity and even more the production of large diameter low-pressure tyres from 1928, very much encouraged and developed by the Army, which gave to four-wheel vehicles, especially those driven in both axles, a high standard of cross-country capacity.

There had been a serious practical attempt in 1911 to produce a cross-country vehicle to serve as a tool cart for an R.E. field company. This commendable instance of foresight and initiative (and

it may be said expenditure of private funds) before the Great War stands to the credit of a Territorial R.E. field company in the East Anglian Division. Captain F. Wilson (now Colonel, D.S.O., T.D.) with the assistance of officers, N.C.O's and men of his field company, designed and constructed in 1911 and used on manœuvres in 1912 a motor vehicle, fitted as a tool cart, which had considerable cross-country capacity and remarkably demonstrated the multiplication of the working capacity of R.E. when they are given mobility. This experiment attracted official attention at once. It was taken up and examined by the R.E. Board, who made a definite recommendation to substitute such vehicles for the horse transport of Divisional R.E. units, but they estimated the cost at £60,000, a sum which in pre-war days was considered unthinkable for such a risky experiment. The reader will find a full description and photographs of this experiment in the article contributed by Colonel F. Wilson to *The R.E. Journal* of March, 1938.

During the war of 1914-18 the R.E. made great use of mechanical transport (I.C. and steam) although it was not on the establishment of their divisional units. At the first Battle of Ypres (October-November, 1914) the R.E. Field Squadrons with cavalry practically discarded their horses and obtained lorries to transport their working parties from place to place, but these parties were much reduced by the necessity to detail men to look after their horses.

The Army Troops Company R.E., which was the first of many new types of R.E. units to be formed for the war, was provided at once with some motor transport (four-wheel 3-ton lorries), since these units had less occasion than divisional units for cross-country work.

The R.E. Anti-Aircraft Searchlight Units were, of course, entirely dependent on motor transport. Pontoon bridge parks were converted to mechanical traction at an early stage of the war.

The Electrical and Mechanical Companies and most other R.E. units on L. of C. and at the base were provided with motor transport. The Director of Roads in France also utilized 700 steam lorries.

In the difficult Balkan country in the long advance made with the Army by R.E. divisional units during and after the final offensive, these units were provided not only with pack transport but with some motor transport and alternated frequently from one to the other. In mountainous country this dual alternating system is essential for all arms.

The advent of the tanks in 1916 soon raised new demands on the R.E. There could be no question but that R.E. working with tanks must be carried in mechanical vehicles, the only point open to discussion being whether these vehicles must be tracked or wheeled, and the bodies bullet-proof or normal. It was also found necessary to create three battalions of mechanized Royal Engineers to work

with the Tank Corps. These battalions were just about to take the field when the armistice stopped the war.

Thus, although during the war of 1914-18 the R.E. had made great use of an enormous quantity of motor transport, their divisional unit transport was still horsed or pack when the war ceased, still awaiting the arrival of the multi-wheel vehicle and the large low pressure tyre to give them cross-country capacity.

Also, from about 1920-26, the country was very active beating the sword into the ploughshare, and the Army had little encouragement or money for making experiments and progress. This influence of idealism was to continue for many years, but in 1926 the Army began with the limited funds at its disposal to enter on a period of experiment to find out what types of mechanical vehicles, and what types of organization and grouping of units would be most suitable for mechanized forces. These experiments continued for some years. Thus, when authority and funds were at last given to proceed with production and reorganization, the Army had made up its mind as to what it required. The tradition of the horse naturally died hard but it was now realized that where a pair of wheels can go they should be mechanically driven and not horse-drawn. The mechanical engineers in civil life and in several branches of the Army had made this possible. Where a pair of wheels cannot go, the transport of the R.E., like that of the rest of the Army, must be on the pack animal, the mule, the donkey, or the camel, or even 50-lb. loads on the heads of human carriers. Here, therefore, let us give a caution to the R.E. and to the Army to maintain their knowledge of animal management and their ability to get through a rough country on horseback. Sometimes it is better to leave the land and take to boat transport on water.

The renaissance of mechanical progress in the Army from 1926 onwards was cautious. It was undesirable to proceed to mass production until exhaustive experiments had been made. The mechanization of R.E. units had to proceed *pari passu* with that of other arms. The writer can, therefore, testify that the R.E. field company of 1931 was virtually identical with that of 1891 in the types of personnel, tools, equipment and horse transport.

Real progress began with experiments to ascertain definitely what the organization, transport, equipment, tools, stores, mechanical plant, and establishment of Mechanical R.E. units should be, particularly divisional units. The R.E. and Signals Board did valuable work for these experiments. The able members of this board will, however, admit their debt to the " Experimental Bridging Company " stationed at Christchurch, which was fortunately under the command of Major (now Lieut.-General) G. Le Q. Martel, R.E., an officer full of progressive thought and ideas,

combined with an unusual ability to give practical demonstration of them, which he owed to his skill as a mechanical engineer.

This "Experimental Bridging Company" was the descendant of the three strong R.E. battalions created in 1918 for work with the Tank Corps. The personnel were the small remnant of these war units who were able to survive in the rarefied atmosphere of peace.

But it was in 1926 that an important turning point was reached with the creation of a mechanized Field Company, by conversion of the 17th Field Company, again fortunately under the command of Major Martel. This Company was to work with the Experimental Armoured Force that was assembled in 1927 on Salisbury Plain. The Company was required to try out, practically, ideas and samples sent to them for trial, and many others initiated by Martel.

It was not only the transport (six-wheeler) which was to be mechanized, it was also necessary to exploit the advantage of M.T. over horse transport in carrying mechanical plant and tools, and to ascertain what items of this nature should be carried. Experiments were also made in operations to ascertain how mechanized R.E. units could assist and co-operate, not only with Armoured Forces, but with other arms also. Great progress was made in these experiments in 1927 and 1928 under Major Martel's direction and in co-operation with the R.E. Board. It was decided to supply the company with pneumatic tools operated by the power from air compressers. The power of the transport lorries was utilized for operating winding gear and for lifting weights with derricks. Mechanical pumps of various types for use in the field, suitable for field company equipment were tried out, together with various types of water supply stores. Later, a portable I.C. pile-driver was found of great use. The best method of loading pontoons on lorries (now the standard pattern) was ascertained.

In operations, the multiplication of R.E. working power obtained by mobility and mechanical plant was frequently demonstrated. "Tank stepping-stones" (*vide The R.E. Journal* of March, 1937) for getting armoured vehicles over shallow rivers were shown to be useful. A "Kapok" raft which could be rapidly launched to transport M.G. and anti-tank guns and light tanks across a river was frequently used. This was the forerunner of the folding boat raft which is now standard service equipment, supplying the long felt missing link between the infantry assault bridge and the pontoon bridge. It is this missing link, rapidly conveying the light support weapons to the infantry, which speedily consolidates the bridgehead.

The Experimental Bridging Establishment, under the direction of the R.E. Board and their design branch, also developed a 60-ft. light box-girder bridge made from some old equipment and launched

with a special launching nose. The demonstrations were so successful that the work was carried to conclusion by the R.E. Board, and the final design was due to Captain R. D. Davies. A 64-ft. bridge was finally evolved, and has now become a most valuable adjunct to hasty bridging operations.

Early in 1929, the Experimental Armoured Force was disbanded and at the same time Major Martel handed over command of the 17th Mechanized Field Company to Brevet Lieut.-Colonel N. T. Fitzpatrick, a worthy successor under whom there was no check of progress. Further items of plant, equipment and stores were tried out.

The experiments with the folding boat equipment were completed, the design again being due to Captain R. D. Davies, who also at this time carried out some remarkable work on the re-design of service trestles and pontoon equipment. A stage in the experiments had now been reached in which it was possible to begin to register decisions for inclusion in final establishments. It was in this period that the Field Park Company for each division began to come into existence as a mechanized unit.

During the war of 1914-18, every division had found it necessary to milk their Field Companies for personnel to form an unauthorized fourth unit. In the very first week of the war the three pontoon vehicles on the establishment of each field company had to be withdrawn from company command and assembled in rear as an improvised unit, lacking much of the personnel and organization of an authorized unit. In trench warfare, the divisional dump had to be filled, administered and distributed, and numerous engineer services had to be carried out for divisional units in the back part of the area.

From 1926 onwards, with the advent of new bridging expedients and the complete re-design of our pontoon equipment of heavier pattern, a controversy arose as to what types and quantity of bridging material should be carried and march with the division. There was the extreme view that the division should have nothing, because with mechanical transport everything (infantry assault bridges, folding boat rafts, light box-girders, pontoons, etc.), could be sent up from the pontoon bridge park. Divisional commanders and staffs and most R.E. vigorously combated this doctrine, urging the necessity for seizing without delay the fleeting moment when an unopposed crossing can be made, and pointing to the numerous insignificant gaps which would delay the march of a division. The latter contention prevailed and the bridging equipment now allotted to a Field Park Company on the establishment of a division was the result.

The R.E. Board and the 17th Mechanized Field Company, under Lieut.-Colonel Fitzpatrick, continued to be the life and soul of all

experimental work, carrying out the most exhaustive and thorough tests of the equipment and plant under trial.

By 1931 a new stage had been reached. Many years had been devoted to experiments practically carried out for divisional units at Salisbury Plain and Christchurch, and for Army Troops Companies and E. and M. Companies at Chatham, under the co-ordination of the R.E. Board. The time had come to give final decisions for the new establishments of units and to proceed to production. An impetus was required to carry us into the productive period, to get us over the dead point. Fortunately this impetus was forthcoming in the Army Council decision to parade a division in the summer of 1931, completely mobilized on the latest war establishments, to demonstrate how the Army would, if required, go to war at that date. No War Establishments for Mechanized R.E. Units had yet received official sanction and so it was decided that R.E. divisional units would parade on the old establishments on a horse transport basis. After all these years of experiments which had told us what we required, were we to demonstrate to the public in 1931 as the last word of the R.E. in thought and progress nothing but units of the last century? It was preposterous, so the C.I.G.S. decided that, if Provisional War Establishments for Mechanized R.E. Units could be drawn up and approved in time and sufficient vehicles and equipment could be collected, the R.E. should fall in on the divisional parade on Mechanized Establishments.

An "ad hoc" R.E. Committee was formed to decide on the new establishment and the new table of mechanical plant, equipment, tools, etc. This work could be done quickly because the results of years of experiment were readily available. Vehicles were available but not all the plant and tools which were, therefore, represented by "mock ups." The 17th Mechanized Field Company existed as a sample. Lieut.-Colonel Fitzpatrick commanding it was able to give great assistance to the Committee in drawing up establishments and tables.

One of the issues raised was: "Should all the personnel of R.E. units be carried in lorries, or only a proportion, leaving the rest to march?" Space is not available to argue this question, nor is it incumbent upon a historian to do more than record events. The arguments of multiplication of working power by mobility, the wide area over which R.E. work is required, the small result to be expected from a sapper who has done a long march, the difficulty for the C.R.E. and company commanders commanding and administering units, some portions of which move at three miles and others at 30 miles per hour, etc., carried the day with the 1931 Committee, and vehicles were provided for all personnel.

At the end of July, 1931, the Mobilized Divisional parade and short manœuvres were held, in which the Divisional Engineers with

the new Field Park Company and the new divisional bridging equipment paraded on the Mechanized Establishments for the first time.

As a result, the Army Council decided that Mechanization of R.E. Units would proceed forthwith, and in 1932 funds were allotted to begin the gradual conversion to mechanized establishments which reached completion in 1937.

The reader will find a great deal of information on this subject in the articles published in "The R.E. Journals" of:—

October, 1920 (G. Le Q. Martel); June, 1927 (R. H. Dewing: G. Le Q. Martel); March, 1928 (E. W. H. Clarke); September, 1928 (G. Le Q. Martel); December, 1928 (J. C. R. Fitzgerald-Lombard); December, 1929 (G. Le Q. Martel); June, September, December, 1931 (N. T. Fitzpatrick); December, 1932 (G. Le Q. Martel); December, 1934 (N. T. Fitzpatrick).

It would be of interest to the corps if some officer, who has war experience, or training experience, of the transport, tools and plant, with which Divisional R.E. Units have worked during the war of 1939-41, *would write an article for "The R.E. Journal" commenting upon the suitability thereof.*

AERODROME CONSTRUCTION FOR THE BRITISH COMMONWEALTH AIR TRAINING PLAN.

By J. A. WILSON, M.E.I.C., *Controller of Civil Aviation, Department of Transport, Ottawa, Ont.*

(*Paper presented before the Montreal Branch of the Engineering Institute of Canada, October 3rd*, 1940.)

INTRODUCTION.

EACH month of the World War, 1914–18, saw a constantly increasing demand for more aircraft—first, for observation, then to fight off the observation planes, and, finally, for bombing military objectives. Young Canada flocked eagerly into the new service and acquitted themselves so well that the Royal Flying Corps established training bases in Canada to enlarge their field of recruitment and supplement their overcrowded home training establishments. Camp Borden, Leaside, Armour Heights, Deseronto, Mohawk and Beamsville were all active flying training schools and Toronto University became the centre of their ground training activities.

History repeats itself—when the crisis came in the end of August, 1939, it was natural that Canada should again play an important part in the war in the air. This time the need was much more urgent. With the expansion of the Royal Air Force, the air space of the United Kingdom was rapidly approaching saturation. Every month saw the creation of new squadrons as the output of aircraft rose. Each new unit required another aerodrome for operations and this, coupled with the expectation of intensive air fighting and the continuous bombing of all aerodromes, made it essential to find other bases where training could proceed without these distractions.

Canada was the only practical outlet. Her accessibility, the satisfactory experience of training in the World War and the known enthusiasm of her youth for the air, made it inevitable that she should become a great flying training centre for the British Empire. Missions from the United Kingdom, Australia and New Zealand reached Ottawa in September and, though a final agreement was not concluded till December, the scale and scope of the plan were determined early in October so that preparatory work could be put in hand.

FIG. 1.—Map showing Location of Flying Training Schools for British Commonwealth Air Training Plan.

(From The Engineering Journal, November, 1940.)

Training Schools Required for the British Commonwealth Joint Air Training Plan.

The original programme provided for sixty-four flying training schools, twenty of which were to be opened in 1940, the first in June, thirty-six in 1941, and the remainder during the first half of 1942. Events subsequent to April, 1940, modified this programme greatly, have increased its tempo and enlarged its scale.

Of the original sixty-four schools, twenty-six were elementary, ten were for air observers, ten for bombing and gunnery, two for air navigation, and sixteen were service flying training schools where intermediate and advanced training is given. At each of the service flying training schools the establishment of aircraft of various types is so large that, when the school is in full swing, two relief aerodromes are necessary to avoid congestion on the main aerodromes. The programme, therefore, called for aerodromes for ninety-six units. It now includes 124 and further extensions may yet be seen.

The Royal Canadian Air Force, hampered for many years by lack of funds for aerodrome construction, had at the outbreak of war only five aerodromes ready for use and six under construction. Their auxiliary squadrons were all based on civil airports. The service aerodromes were, of course, required for operations immediately the war began and were not available for the training plan.

Due to the energetic support of the Honourable C. D. Howe, M.E.I.C., there had been great activity in the building and improvement of civil airports in all parts of the country since 1936. This was principally along the line of the trans-Canada airway but included many airports to serve feeder lines as well. The use of this chain of airports, built to a common, up-to-date standard, as a foundation for the plan, was the obvious solution of the problem and the Civil Aviation Division was, therefore, called into consultation by the middle of October and the decision reached, soon after, that the responsibility for finding and building the aerodromes required for the programme should rest on it.

Organization of the Training Plan.

While the discussions leading to an inter-governmental agreement were proceeding, organizations were being created to supervise and execute the training plan. A Supervisory Committee was formed consisting of three members of the Canadian Cabinet, the Minister of Defence for Air, the Minister of Munitions and Supply, and the Minister of Finance; the High Commissioners for the United Kingdom, and Australia; the Chief of Air Staff, R.C.A.F.; the Air Member for Training, R.C.A.F.; Senior Officers from the Royal, the Royal Canadian, the Royal Australian and the Royal New Zealand Air Forces, and a representative of the Treasury.

Under this committee, the responsibility for the administration of the training plan was placed in charge of the Air Member for Training of the Canadian Air Council, Air Commodore G. O. Johnston. A committee was formed in his organization to deal with aerodrome construction.

With this committee the officers of the Civil Aviation Division have worked in the closest liaison. The Superintendent, Airways, Department of Transport, and Airway Inspectors and Engineers of the Civil Aviation Division attend its meetings and furnish the committee with full information on all matters under consideration. The committee indicates to the Department of Transport desirable locations for the various types of schools. Following preliminary investigation reports, a field party, consisting of an inspector and an engineer of the Department of Transport and an Air Force officer, decides in the field on the sites upon which detailed surveys should be made. When detailed surveys are received by the Department of Transport, engineering plans and estimates for the development of the site are prepared and submitted to the Director of Air Services, Mr. C. P. Edwards, M.E.I.C., and the Deputy Minister of Transport for approval. If approved, these are passed to the Deputy Minister of National Defence for Air in a letter giving these estimates in detail. This estimate is then considered by the Aerodrome Development Committee, the merits of the site compared with others, and a final decision is reached as to whether it should be developed. The committee then recommends to the Minister of Defence for Air that funds be made available from the appropriations for the Air Training Plan for the development of the site. If this is given, a financial encumbrance making available to the Department of Transport the sum necessary for the development is prepared, allocating funds for the purpose.

ORGANIZATION OF DEPARTMENTAL FORCES.

The Superintendent, Airways, of the Civil Aviation Division, is in charge of the detailed execution of all work for the plan undertaken by the Department of Transport. He had wide experience in aviation, having been a pilot in the last war, and made the original aerodrome selections in the prairie provinces in 1929 and 1930 for the trans-Canada system and has since then been responsible for the airport planning and construction on the trans-Canada airway and elsewhere in the Dominion.

In the fall of 1939 every member of the staff, who could be spared, was put on this work so that ground surveys might be started as quickly as possible. Their job was to select the sites; supervise the detailed surveys and see that all pertinent information was placed on the survey plans; assist as necessary the Canadian National

Railways' land agents in obtaining options; and consult with the civil engineering staff in regard to the efficient construction of the airport from the airman's point of view.

The formation of a suitable engineering organization to carry out the construction work was simplified, because the Department already had an engineering staff which had been busy on the building of the trans-Canada airway for the past eight years and had, therefore, a wide experience in this new phase of engineering which could only be obtained through practical experience. They were familiar with the conditions and problems to be faced in the different districts of the Dominion. This organization, however, was comparatively small and it was necessary to enlarge it greatly. The size of the programme and the speed with which it must necessarily be carried out made it desirable to divide the work between two organizations at headquarters so as to reduce the burden on the key engineers of the organization.

The existing airway engineering staff were fully familiar with the then existing airports as they had built them. It was accordingly decided that they should be made responsible for the improvement of the present aerodromes which might be used for the plan and all work connected with them, and that the new temporary airway engineering organization should be formed to deal with all new aerodromes. This new organization was given the services of certain of the experienced key men from the permanent staff to assist them.

The idea underlying this division of engineering work was that so far as circumstances permitted, the continuity of work on the trans-Canada system should not be interfered with by this large new programme which had suddenly been imposed on the Division and that, when the Air Training Plan work was over, the temporary staff could be released and our permanent organization would continue their normal duties. In addition, it should be remembered that, though the trans-Canada airway had been in successful operation for two years, much work was still required every year to bring it up and maintain it to the required standard.

This form of organization, though adopted with some misgivings at the time, seemed to be the best way of getting the work done in time, and it has worked admirably. This division of responsibility only applied to headquarters, as in the field the work all comes under the district airway engineers, most of whom had had long experience in such work under the Department. All work in each province was controlled from the district offices, and resident engineers were appointed on each project to supervise the work.

An electrical engineering section was already in existence in the Civil Aviation Branch to deal with problems arising out of lighting, power and communication services.

Engineers with specialized knowledge and training were added to

the headquarters staff to deal with paving specifications and inspection, water supply, and the production of turf surfaces on the aerodromes.

AIRPORTS IN CANADA ON OCTOBER 1ST, 1939.

The airport situation as of October 1st, 1939, may be summarized as follows: the total number of airports and airport sites yet undeveloped, but about which information was on record, was 153. A rough and ready classification of existing airports and sites showed :—

1. Airports of developed dimensions of 3,000 ft. or more .. 37
2. Airport sites known to be capable of development to 3,000 ft. or more and of which surveys had been made 5
3. Airports then in use under 3,000 ft. 46

In the first two classes were the airports of the trans-Canada system and those in preparation for its extension. This had been built for civil transportation but when the crisis came its construction was seen to be doubly justified. No project of more importance to national defence had been undertaken since the World War. Good airports at hundred-mile intervals, with emergency landing fields at closer spacing in unsettled and difficult country, hangar accommodation, weather and communication services, and radio aids to air navigation and lighting, were in being from coast to coast, which allowed the free movement of aircraft and gave the R.C.A.F. fine modern airports for the rapid expansion of their service.

The trans-Canada airports had been built as transport airports, that is, they were not all-way turf fields as preferred by the Air Force, but built on landing strip principle, by which a system of two or more landing strips 500 ft. wide by 3,000 ft. or more long are laid out on the field in the form of a triangle, " < " " + " or " T " shape, and the rest of the field cleared and rough graded only. This was the most economical development and fully met transport requirements. Since the sites had been carefully selected and planned for future development, to adapt these airports to Air Force use for elementary and air observers' schools was comparatively simple, calling for the fine grading and seeding of the other portions of the transport aerodromes not previously finished and by adding taxi strips to give access to R.C.A.F. hangars as necessary. Experience had shown that, if an aerodrome is required for use at all seasons of the year, hard surface runways were necessary to give sufficient bearing during the spring and fall seasons. Such runways had been built at all major airports on the airway system.

Certain sections of the trans-Canada airway and its connections were not suitable for training purposes because of inaccessibility, climate, proximity to the international boundary, or the nature of

the surrounding country. This applies particularly to northern Ontario and the Rocky Mountains. Nova Scotia was considered out of bounds, too, as far as training was concerned, as it was the scene of intensive active service operations. Many fine aerodromes could, therefore, not be considered, but the Department of Transport was able to offer for the use of the training plan, as soon as buildings to accommodate the training schools could be built, twenty-four airports, which required, in most cases, comparatively little work to adapt them for training purposes. (See Fig. 2.) As some of the larger airports could accommodate both an elementary and an air observers' school, these twenty-four airports could accommodate fourteen elementary, one air navigation, six air observers, two bombing and gunnery schools, besides the main aerodromes for twelve service flying training schools and relief aerodromes for two more. The existence of these ready-made airports made possible the acceleration of the training plan. Twice as many elementary flying training schools and service flying training schools would be open before the end of 1940 as had originally been contemplated.

Selection of Sites for New Aerodromes.

As shown in the preceding paragraph, existing airports could take care of about one-half of the original programme. New sites must, therefore, be found for the remainder. Time pressed. October was already half gone and the advent of snow would increase the difficulty of making reliable surveys. Field parties were, therefore, organized as quickly as possible in the three prairie provinces, southern Ontario and Quebec, and the maritime provinces, to find all the new sites required before the winter set in. These parties consisted of an airway inspector, an airway engineer, both experienced in the location and construction of aerodromes, and an R.C.A.F. officer.

The selection of aerodrome sites, even in the prairie provinces and in good agricultural land, is not an easy task. Good drainage is the first essential. All approaches to the aerodromes must be clear of obstructions. The ordinary amenities of civilization are very necessary near these schools. They must, therefore, be easy of access by road or rail to some nearby centre of population. Ample water supply, proximity to a reliable power supply and to good road-building material are also essentials.

The Air Force organization for the training plan provided for four separate training commands, two in western Canada and two in eastern Canada. It was desirable that the whole programme should be divided between these four commands as equally as circumstances permitted. On other grounds it was desirable that the activities of the training plan should be as widespread as the physical character and climate of the Dominion permitted.

In the prairie provinces the climate and terrain were particularly suitable for a plan of this kind. Western Canada could have accommodated the whole programme, if this had been necessary. The uncertainty of water supply and difficulty of growing good turf were handicaps, as well as its distance from the main centres of population and industry. The endeavour has been to secure, to all parts of the country, the benefits arising from the large expenditures involved in building aerodromes for the training plan. Every effort has been made as well, in the location of the new aerodromes, to ensure that they will be of some use in the post-war period and will serve the peace-time needs of our growing civil air transportation system.

The plan of operation of the survey parties was to study in the office the topographical maps available of each district and mark on them the locations where a level area of approximately one square mile could be obtained. A reconnaissance was then made from the air of such areas, noting particularly the approaches to the site, its accessibility by road and rail, and indications of drainage so as to avoid swampy and low-lying areas. After this reconnaissance, an examination on foot was made of the apparently suitable sites and preliminary investigation reports of these were prepared. These survey reports were then forwarded to Ottawa by air mail for discussion with the Air Training Command. The most favourable were then approved for detailed ground surveys. A reconnaissance was made of approximately 2,000 sites, survey reports were filed of over 200 and topographical surveys were made of about 150 sites. It is safe to say we know the location of practically every suitable aerodrome site in the districts covered.

It was essential, if real progress was to be made during the summer construction season of 1940, that detailed engineering surveys of the sites required during 1940 and 1941 should be available in the Ottawa offices by the end of 1939. This would enable construction plans and specifications to be drawn up for the work during the winter months, so as to permit of tenders being called for early in the spring and work started just as soon as the frost was out of the ground. If this could be done, the full working season of 1940 would be taken advantage of. All sites required during that year and two-thirds of 1941 must be completed in the fall of 1940, as winter conditions do not permit of aerodrome construction in this country.

AIRPORT SURVEYS.

The problem of putting fifty or sixty survey parties to work at short notice was solved with the assistance of the provincial highway departments, who were then laying off their highway survey parties for the winter. The whole-hearted co-operation of these services and the open nature of the fall season of 1939 made possible the com-

FIG. 2.—Ottawa Airport Modified to Service Flying Training School.

FIG. 3.—Macdonald, Man., Bombing and Gunnery School Aerodrome looking East.

FIG. 4.—Runway Construction at Medicine Hat, Alta., Wobble Wheeled Rubber Tyred Roller Compacting Base Course.

FIG. 5.—Collins' Bay (Kingston)—Main Aerodrome for Service Flying Training School.

British Commonwealth air training plan 2, 3, 4, 5

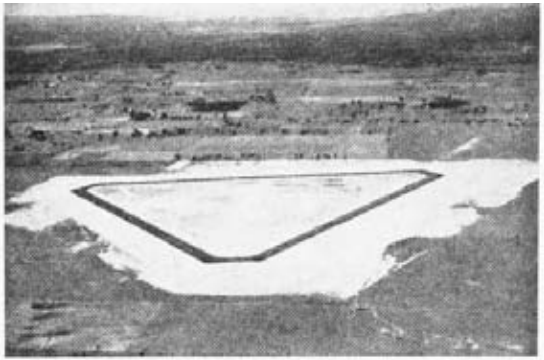


FIG. 6.—Gananoque Aerodrome—Relief Aerodrome No. 1 for Collins' Bay.

FIG. 7.—Airport Drainage—Using Blade Grader for "V" Ditch.

FIG. 8.—Stone Filled "V" Ditch.

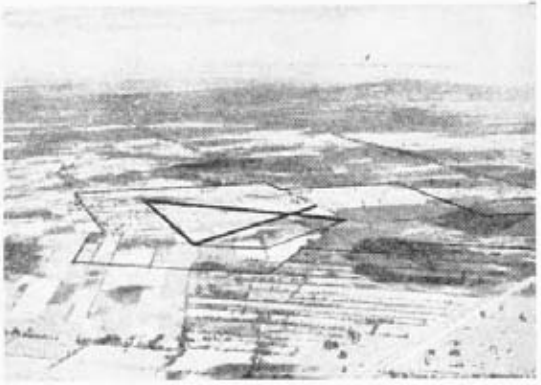
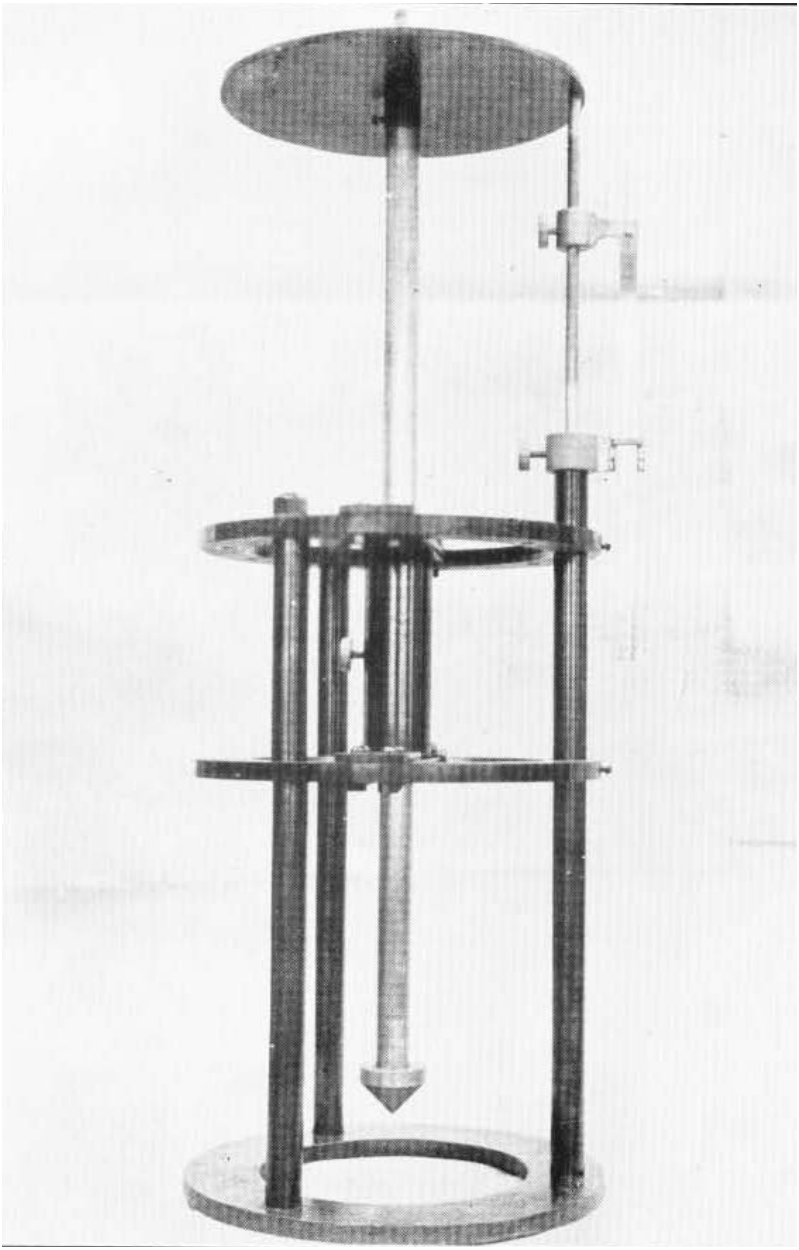


FIG. 9.—Air Photograph Showing Dorval, Que., Site.

British Commonwealth air training plan 6, 7, 8, 9



Cone penetrometer opp p 90

pletion of 80 per cent of the surveys before the snow fell. This saved at least six months in the execution of the programme and gave the airway engineering service of the Civil Aviation Division the four winter months to prepare their plans and specifications. The contour plans of the aerodrome sites furnished by the provincial highway engineering departments were certainly a credit to these services.

The work was done with great speed but in spite of this, the most accurate details were given of our requirements. All winter long, as the survey plans were received, work went on in laying out the aerodromes to take the best advantage of the natural features of the site. Plans and specifications for the grading, drainage, hard surfacing and lighting were then put in hand. At the same time, full information was made available to the R.C.A.F. so that their buildings might be planned to fit in with the general development.

The elementary schools call for an all-way turf surface, as only light aircraft are used and, with the exception of a week or two in the spring when the frost is coming out of the ground, experience shows that in most districts no expensive hard surfaces are necessary. The air observers, bombing and gunnery, air navigation, and service flying training schools required hard surfaces, as their aircraft are all heavier types and the continuous operation required could not be guaranteed at all seasons of the year without pavements. These were usually laid out in a triangular form to provide for 3,000-ft. runways, sea-level basis, in six directions of wind.

The interior triangle bounded by the runways is fine graded and seeded to grass, as well as a 250-ft. strip on the outside of the pavements. At the service flying training schools it was necessary to provide for the landing of five aircraft abreast. The landing strips were, therefore, at least 1,000 ft. wide with two hard-surfaced and three grass runways. Under the worst conditions, the two hard-surfaced runways provide for two simultaneous aircraft movements, or provide for one-way traffic with a return strip for taxi-ing on the ground.

Zoning.

The adequate zoning of the aerodromes presented another problem. Power was taken under the Defence Air Regulations to pass regulations preventing the building of obstructions on property adjacent to an aerodrome used for national defence purposes at a ratio of 50 : 1, that is, 1 ft. vertical for every 50 ft. horizontal from the end of each landing strip for a flightway width 600 ft. wider than the landing strip of 500 ft.–1,000 ft., and one in twenty at other points on the perimeter. Wherever possible, ample land was taken to provide for the extension of the landing strips to 5,000 ft. should this be found necessary.

The zoning of the aerodrome must not only prevent the building

of obstructions on its boundaries but must also provide that buildings on the aerodrome do not interfere with the free use of the landing areas by aircraft. Buildings were, as far as possible, concentrated in one area, preferably convenient to the landing strip in the direction of the prevailing wind, to reduce the amount of taxi-ing to the minimum, and to good entrance roads. Hangars were set back on a zoned line parallel to this strip with provision for a 150-ft. taxi strip and a 200-ft. apron in front of the hangar entrance, so that aircraft could stand out for refuelling and running up, and, awaiting their turn, use the field without interference with flying operations. Clearing rights on adjacent properties were obtained where necessary and buildings, trees, power lines and other obstructions were removed to the required ratios.

* * * * *

POWER, LIGHTING AND TELEPHONE SERVICES.

The Department of Transport undertook to provide power, lighting and telephone. Here again there was an experienced organization ready to tackle this phase of the work, as it was no different from equipping the trans-Canada airway with similar facilities.

The provision of power is a major item. Certain schools have as much as 1,000 h.p. Most of this energy is required for lighting, with a smaller part for motor load. This load is the equivalent in size to a town of a thousand to fifteen hundred population.

In the eastern provinces, including Quebec and Ontario, little difficulty is experienced in meeting the power requirements. These provinces are covered with a power network, so that comparatively short lines only are required. However, for the larger loads, it has been necessary in most cases to reconstruct sub-stations.

In the western provinces power is at a premium, particularly where it is generated by steam or Diesel plants. It has necessitated interlinkage of smaller systems to get better diversity and increase quantity. In some instances, stand-by plants are brought into continuous operation. In one case, it has been necessary to add two prime movers; that is, Diesel plants.

It might be of interest to note that the total demands for all schools will probably be as high as 20,000 kw. This is a good-sized load, but due to its being distributed across Canada it has been established without major plant construction.

It is the responsibility of this Department to negotiate for such power line and distribution system construction as is required, to see that incoming lines do not obstruct flightway approaches, and to see that existing lines are removed where necessary. The problem of salvage must be considered; if at some future date the projects are abandoned, contracts must be prepared to allow for construction and for energy consumed. Provision of power for water supplies and for heating equipment must also be undertaken.

In lighting the fields for night flying, only the advanced training schools are equipped. In this regard, the Department acts as contractor by preparing plans, ordering materials and organizing field crews to actually install all equipment. In short, the equipment consists of contact lights for each hard-surface runway, a rotating beacon, code beacon, an illuminated wind tee and a ceiling projector for measuring cloud height at night.

These lighting facilities will be provided, with certain variations, at some fifty-five schools.

A telephone system is provided at each site, and at the larger schools a regular switchboard is required. Connections have to be made to bombing ranges, which, in most cases, require ten to twenty miles of interconnecting lines. Trunk lines must be established between the school and the urban centre that is close by.

The establishing of these three services for all schools is well advanced, in spite of periodic advancement of opening dates. It is estimated that these services will amount to more than two and a half million dollars when completed.

In all this work the Department has had the ready co-operation of provincial power commissions, power companies and municipalities all over the Dominion. A great deal is due to them for their wholehearted assistance.

In the communication field the help of the Bell Telephone Company has been invaluable. They have not waited our instructions, but have anticipated them in a wonderful way by preparing connections as soon as the sites were selected, so that by the time the orders were placed we found the connecting lines available. They have acted in this way not only for their own systems but for provincial and local telephone services as well.

Runway Construction.

Due to the heavy aircraft traffic it was necessary to construct hard surface runways and taxi strips on all service flying training schools' main aerodromes and one relief aerodrome to each main, as well as on all bombing and gunnery schools, air navigation schools and air observers' schools.

As has been seen, the service flying training school's main aerodrome has three double runways, 100 ft. wide and 2,500 ft. long, each at sea level. The reliefs have three single runways, 100 ft. wide and 2,500 ft. long at sea level, but the layout on the relief aerodrome is designed so as to provide room for three additional runways if required.

The bombing and gunnery schools, air observers' schools and air navigation schools have three single runways, 150 ft. wide and 2,500 ft. long, at sea level.

The type of construction depended on :—

1. Type of aircraft as well as number of aircraft used ;
2. Soil condition ;
3. Available aggregate ;
4. Available construction equipment.

The bombing and gunnery schools required the best type of runways, due to the heavy aircraft used.

The most common runway bases used are :—

1. Crushed gravel ;
2. Crushed stone water-bound macadam ;
3. Suitable soil, gravel and bitumen ;

and the most common runway tops used are :—

1. Bituminous hot mix ;
2. Bituminous road mix ;
3. Bituminous penetration.

The thickness of the pavements depended on the bearing quality of the soil and the type of aircraft, and varies from 5 in. to 10 in. base and 1 in. to 2 in. top.

On nearly all aerodromes, stone backfill runway shoulder drains have been constructed with manholes and catch basins at approximately 400-ft. intervals, with perforated manhole covers.

WATER SUPPLY.

Competent technical advice has been secured and thorough investigation made to ensure a dependable, clean and adequate water supply for each aerodrome. The gallonage per day varies with the different types of schools, the elementary calling for 8,000, the observers 12,000, the service flying training and air navigation 40,000, and the bombing and gunnery 45,000 gallons.

Sources of supply have been determined by considerations of safety, health and economy. Thus, provision must be made for the protection of buildings and personnel against fire ; the Department of Pensions and National Health has co-operated with provincial departments of health in making chemical and bacteriological analyses ; and careful study has been given to comparative costs of available sources, equipment and appurtenances.

Sources of water supply fall naturally into two groups. In the larger of these are the airports, for which an independent supply has been obtained by the development of ground or surface water by means of wells or from lakes or rivers. In the other group are those aerodromes adjacent to towns or cities in which a municipal waterworks system is now adequate or can be made adequate to take care of the requirements of the aerodrome.

Many of these municipalities have not waited to be approached in this connection, but have themselves taken the initiative. In addition

to submitting proposals to supply water, in some instances at rates less than the actual cost to the municipality, municipal corporations and public utilities commissions have placed the facilities of their organizations and the particular knowledge of local problems at the disposal of the government. A willingness to embrace the opportunity to advance such work characterizes the attitude of civic officials and commissioners in every case.

Among the municipalities which have co-operated in this manner are Brantford and Picton in Ontario; Brandon, Dauphin and Portage-la-Prairie in Manitoba; Moose Jaw, North Battleford, Saskatoon and Yorkton in Saskatchewan; and Claresholm, McLeod and Medicine Hat in Alberta.

As may be imagined, many difficult problems have been faced in this phase of the work and it should be remembered that owing to the urgency of the programme it was not always possible to await a final solution of all its many sides before starting construction work. This was specially true in western Canada but in no case has the opening of any school been delayed through the failure to obtain a satisfactory water supply. In one or two cases, however, construction on an otherwise satisfactory site has had to be abandoned for lack of a good supply of water.

Seeding.

On many of the airports a grass turf is to be used exclusively, and even where hard-surfaced runways are provided the turf is most important. In all cases a satisfactory turf has to be obtained in a minimum length of time, to make the airports available for immediate use.

The magnitude of the work can be realized when one considers that on some seventy airports a total of over 20,000 acres must be seeded this fall or early next spring. Each airport requires individual treatment in the selection of a suitable grass mixture and fertilizer for the various soil types and climatic differences.

The Department of Transport was fortunate in obtaining the services of the Department of Agriculture. With the co-operation of the various agronomists of the Dominion experimental farms and of several agricultural colleges, and soil surveyors in the different provinces, a botanical and soil survey was organized. From the botanical analyses it was possible to select the most suitable grass species for each individual site. The soil survey reports and soil maps furnished valuable information from which the most suitable fertilizer for each site was selected.

On the airports where subsoil was exposed or where the existing topsoil was not of satisfactory quality on which to obtain a good grass turf, it was necessary to add additional topsoil. All topsoil used for this purpose was carefully selected. Much valuable assistance

by Departmental forces excepting lighting installations has cost $117,600, and the cost of Departmental engineering inspection and services $289,802. The total sum encumbered to date is $17,793,000. These contracts involve the moving of some 20,000,000 cu. yd. of earth; the laying of some 300 miles of drains from 6 in. to 36 in. in diameter, and the paving of 10,000,000 sq. yd., equivalent to over 800 miles of standard highway 21 ft. wide.

The average cost of aerodromes for the different classes of schools is as follows:—

Elementary School aerodrome, all-way field, with grass surface, acreage from 200 upwards ..	$100,000
Air Navigation, Gunnery and Bombing and Air Observers' School aerodromes, all-way fields with three hard surfaces 3,000 ft. × 150 ft. and hard-surfaced taxiways 500 acres and upwards ..	$350,000
Service Flying Training School: one Main field where all living quarters, hangars, shops, etc., are concentrated, with double, triangular, hard-surfaced runways; one Relief field with hard-surfaced triangular runways and one all-way turf Relief field.	
TOTAL for all three aerodromes	$800,000

PROGRESS TO SEPTEMBER 30TH, 1940.

In spite of exceptionally wet weather in May and June, which made grading in clay soils very difficult and jeopardized the success of the programme in some districts, work has gone well. The contractors and their staffs have been in most cases fired with patriotic zeal and have worked manfully day and night to meet the emergency.

In the case of the earliest opening of schools, construction had to be finished while the school was in operation, but part at least of the field was ready for use. The staffs of such schools have carried on cheerfully in spite of the inconvenience of having contractors' machinery working on part of the field.

Grass cannot be grown overnight and some of the fields will be dusty in dry weather and muddy in wet weather till the turf is established. Such trials were inevitable. They have been faced philosophically by the operating staffs as part of the job.

Good drainage is a first consideration. The drainage of approximately a square mile of level land so as to provide a quick run-off is not an easy problem and has called for careful study of each site. Conditions vary greatly. At Ottawa, the aerodrome is on pure sand and all that is necessary is to sink manholes below frost level and the water disappears. In some clay soils it is a very different matter and elaborate drainage systems are required. Stone filled ditches to below the frost level line all the hard surfaces on both sides and lead

to natural drainage outlets. The precaution has been taken to make the paving on the hard surfaces as dense as possible, so as to prevent water percolating through to the clay base and softening it or cause heaving in spring from frost action. Where any considerable cut and fill is involved one cannot guarantee a perfect job during the first year. Settlement takes time and weak spots will show up next spring. Their rectification will not be serious, however, and by next summer when settlement is complete, drainage working and turf established, the training schools will be well found so far as their aerodromes are concerned.

Progress to date justified the statement that in no case will the opening of any school by the revised dates required by the R.C.A.F. be held up by the lack of a usable aerodrome. The dates of completion vary with the amount of work to be done, the priority to be given to the particular site and the weather. Expansion of the programme in July modified greatly the sites originally selected for elementary or air observers' schools and on which grading was already well advanced. Some of these were now modified for use as service flying training schools. The necessary hard surfaces and extra drainage were installed and the additional property required for the larger school was acquired. Elsewhere, an air navigation school was added on an aerodrome which previously had only been proposed as an elementary school and the necessary modifications were made to the contract specification. In some cases, too, the size of the elementary school was doubled, so as to avoid having to construct a new aerodrome. Out of a total of 75 schools, 32 would have their aerodromes completed by September 30th, 1940, with a further 33 scheduled for completion by December 31st, 1940. Compared with the original programme of 64 schools for which aerodromes had to be completed by June 30th, 1942, we shall have completed aerodromes for 65 schools in 1940, leaving only 10 to be carried over into 1941. The following table shows the position :—

DATES OF COMPLETION.

(Except seeding in some cases.)

	By Sept. 30/40.	*By Dec.* 31/40.	1941.	*Total.*
Elementary Flying Training School	13	12	1	26
Air Navigation School	1	1	1	3
Air Observery School	7	1	3	11
Bombing and Gunnery School ..	2	8	1	11
Service Flying Training School ..	9	11	4	24
	32	33	10	75

* * * * *

ECLIPSE OF A DIVISION.

By COLONEL CARY I. CROCKETT, *United States Army, (Retired).*

(Reprinted from the "Infantry Journal" (Washington) of January, 1941.)

THERE is hardly an officer in our army who has not pondered over what day-by-day life must have been for the British soldier of the divisions sacrificed in the effort to withdraw the B.E.F. from France.

The operations in June of the British 51st Division—the Highland Division—give a glimpse of the pattern of events in that organization during the historic fourteen days of continuous fighting against hopeless odds.

During May, the Highland Division had held a sector of the Maginot Line, but as the Dunkirk withdrawal drew to a close it was moved rapidly from the Metz and Verdun localities to the westward.

As a grim omen of the future, the 51st had two days of uncertainty while the High Command deliberated whether to use the division against a German break-through near Montmédy, or in an attempt to stop the German drive against Paris.

Varennes, the town in the valley of the Aire, familiar to men of the American divisions that were on the western wing of our First Army during the Meuse-Argonne battle, was the first position in readiness designated for the Highland Division; then it was shifted rapidly to the vicinity of Gisors, north-west of Paris. But there was no stop at Gisors. As the troops arrived by motor transport and train they were hurried on to the Bresle River, preparatory to advancing northward and taking over a wide portion of the line of the Somme nearest the sea.

But the Germans had secured bridgeheads across—that is, on the south bank of—the Somme. Therefore, on May 28th, when the leading elements of the Highland Division pushed ahead beyond the Bresle to gain contact with the Germans, now already across the river from Abbeville, a British armoured division, in conjunction with some French tank companies, attacked the German bridgeheads. This attack was partly successful; the bridgeheads were almost entirely reduced. But the armoured division suffered such losses, that all but part of one brigade was ordered back to refit near Rouen.

The mission then assigned the Highland Division was to occupy and hold a frontage of eighteen miles on the Somme, with its left flank resting on the English Channel—a long line indeed for only two brigades.

The French IX. Corps had promised to capture the German bridgeheads at Abbeville before turning over the sector to the British, but the attack of May 28th and another on May 30th failed to accomplish this. Nevertheless, on June 1st the Division took over defence of the Somme on the extended front originally assigned.

is being given by the experimental farms in assisting the Department in this work.

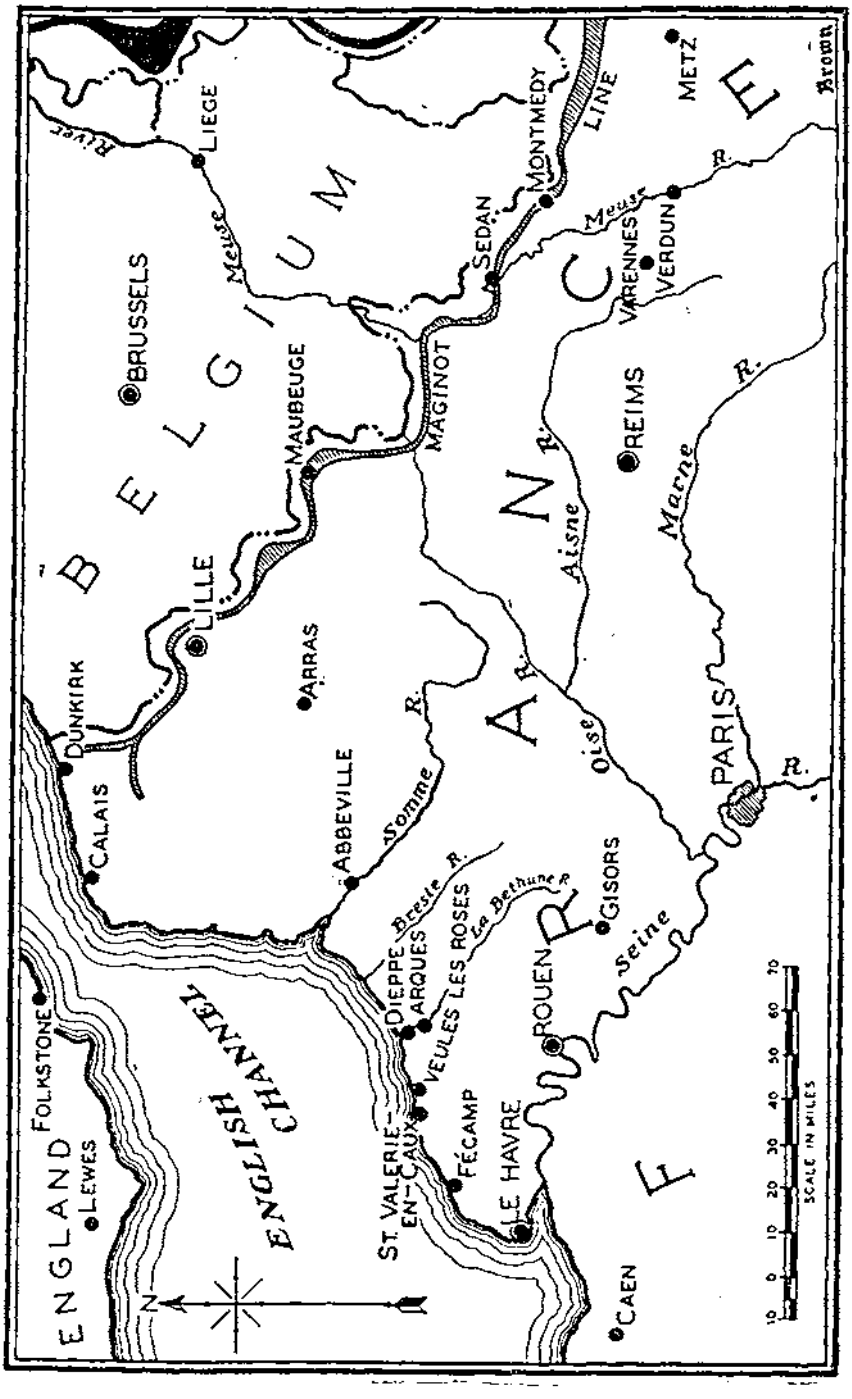
CONSTRUCTION CONTRACTS.

Contract plans and specifications began to trickle through to the Contracts Branch in February, 1940, and increased rapidly to a steady stream during March and April. Public tenders were called for during these months and tenders were awarded to the lowest bidder whose tender complied with Departmental requirements. Herr Hitler's rapid work in Europe then hastened the tempo of the training plan, and, to save the inevitable delay this course entails, restrictions were withdrawn and many contracts have been negotiated direct, on an agreed unit price basis, with known reliable contractors. The calling of public tenders on the earlier jobs had established a range of fair prices for each class of work in different districts, which made a good guide for these negotiations. So many contracts were being let that the services of all reliable contractors experienced in highway work could be used as soon as the plans and specifications were completed and the properties purchased. Later in the summer it was necessary to ask eastern contractors to invade the West, as firms there all had their hands full.

To press the work and finish as many projects as possible before cold weather came in the fall, the contractors were put on their mettle ; and it is very gratifying to be able to state that practically without exception they rose to the emergency, keeping their units operating twenty-four hours a day and seven days a week, whenever weather permitted. The main contracts included clearing, stumping, drainage, grading, paving, seeding and fencing. Aerodrome lighting was done by our own field parties, whose foremen had made all installations on the trans-Canada airway and were more familiar with the work than any contractors' gang could be. Power, telephone and water supply were, in all cases, separate contracts.

To September 30th, 94 aerodrome construction contracts had been let, as well as a very large number of subsidiary contracts covering miscellaneous necessary works and material not provided for in the main contracts.

To date, the sum made available by the Department of National Defence from the Joint Air Training Plan's appropriation to the Department of Transport is $24,313,810. This sum is based on the estimated total cost of the development of each project based on our construction plans and specifications plus the land value. Main contracts have been let for 94 projects involving approximately $11,577,628. In addition, the Department has purchased direct for use on these projects $1,870,915 worth of bituminous materials for paving ; grass seed and fertilizer $105,678 ; lighting equipment $717,271 ; contracts for power line construction and power services let to date $138,140 ; water services $186,185. Work done


ENGLAND
FOLKSTONE
LEWES
ENGLISH CHANNEL
BELGIUM
BRUSSELS
LIEGE
River Meuse
MAUBEUGE
LILLE
DUNKIRK
CALAIS
ARRAS
ABBEVILLE
Somme R.
Bresle R.
DIEPPE
ARQUES
VEULES LES ROSES
La Bethune R.
ST VALERIE-EN-CAUX
FÉCAMP
LE HAVRE
ROUEN
Seine
GISORS
Oise R.
Aisne R.
MAGINOT LINE
SEDAN
MONTMEDY
REIMS
Marne R.
PARIS
R.
VARENNES
VERDUN
Meuse R.
METZ
Brown
CAEN
N
SCALE IN MILES
0 10 20 30 40 50 60 70

Intelligence reports from all sources showed that a German offensive across the Somme to the south was imminent. To block this offensive, the bridgeheads—now reinforced and strengthened by the Germans—had to be captured. The High Command therefore directed that a third attack be launched at dawn on June 4th, the main blow to be delivered by French tanks and infantry, with British infantry and artillery supporting the French on both flanks.

After the Allied artillery had put down a heavy concentration from 3.00 to 3.30 a.m. on June 4th, the French heavy tanks advanced, followed by their lighter tanks and infantry.

Unlocated German anti-tank guns and mines destroyed practically all the French tanks. As a natural consequence the infantrymen following the tanks were mowed down, and their advance halted, by German machine-gun fire.

On the east flank of the main effort the Cameron Highlanders ran into a strong German force. The Germans, who were also attacking, had avoided the French preparation fire, and were pushing vigorously ahead. When the two forces came together, neither side gave quarter, and casualties were heavy. Although the Camerons were without the support of the tanks—all of which were now out of action—they continued to advance until the leading companies were destroyed almost to a man. Despite frightful losses they took their initial objective and held on under heavy machine-gun and mortar fire until nightfall. The order then came to withdraw.

On the left flank the Seaforth and Gordon Highlanders also attacked, captured their objectives and held them until they were likewise ordered to retire under cover of darkness.

The breakdown of the main attack in the centre, which was planned and delivered by the French, rendered futile the action of the Scotch regiments on the flanks. The entire operation was therefore a disastrous failure, because of the losses in men and fighting vehicles.

German pressure continued to increase, and the next morning, June 5th, a general withdrawal to a line about five miles south of the Somme was ordered. The division held this line throughout the day, but had to carry out another withdrawal five or six miles farther to the south, again under cover of darkness. They held the new line until the night of June 6th–7th, when the division fell back across the Bresle, the rear elements destroying all bridges.

The two brigades—the 152nd and the 154th—had been assigned such a wide frontage to cover (the 154th alone had a frontage of over eight miles) that effective co-operation was impossible.

The orders for holding such an extensive front had come from the French. In this connection it may be of interest to point out that in our own analyses at Fort Leavenworth of French tactical methods, based on the study of reports on their annual manœuvres of 1937 and 1938, this tendency towards over-extension was noted and condemned.

The German columns of both motorized and marching infantry, carrying light automatic weapons, machine-guns and mortars, smashed ahead, rapidly over-running and capturing or destroying a number of isolated units. A battalion headquarters unit of the Argyll and Sutherland Highlanders became separated from the main body and a battalion of the Black Watch organized a counter-attack to save it. But the Germans came on so swiftly that there was no time to launch the counter-attack. By the afternoon—June 6th—the Argyll and Sutherland Highlanders had lost two-thirds of their original strength. One company, however, reported as lost, after having been cut off and surrounded by Germans for two days, made its way through the hostile forces and eventually rejoined its battalion.

The withdrawal of the Highland Division under cover of darkness successively from one line to another line five or six miles in the rear, seems to have followed in general the principles and doctrines familiar to our Army. But to "withdraw under cover of darkness" is so easy—in the class-room. What must it have been like to the Highlanders, battle-worn, and exhausted, all magnificent fighters but now realizing that they were hopelessly outnumbered and outclassed in weapons!

During the attack against the bridgeheads the Highland brigades had lost so heavily that when the order came to hold on the Bresle the High Command had to form a composite force, known as "Brigade A," from another British division and hurry it forward to take over part of the line fronting on the Bresle.

Even so, the Bresle line could be held only one day. On the evening of June 7th word came to the division headquarters that German tanks and motorized infantry had broken through the French on the right of the division, and were making for Rouen. And Rouen was the divisional base of supplies!

One can imagine the effect that this news had on the spirits of the worn-out commanders and staffs at division and brigade headquarters. In all probability the bad tidings were withheld as long as possible from the subordinate commanders and troops who, after having had to bear for days and days the brunt of continuous fighting, must now be called on to endure still more terrible trials.

All ranks of the division and its attached units had now been battling constantly for a week, with hardly an hour's rest. The troops moreover had been subjected night and day to dive-bombing and other air attacks. They had been pressed persistently by superior forces.

The line of the Bresle was still intact. But now (June 8th) the problem of supply had become serious. A quick shift in arrangements on June 8th provided for obtaining all supplies for the division, except ammunition, from Le Havre, and for an ammunition train to be run from the Rouen depot to the division refilling points. It will be seen, however, that staff arrangements in actual combat, unlike

those solved in the map-problem room, do not always work out according to plan. Here again the frictions of war often wreck the most careful calculations.

On this same day—June 8th—orders came from the French IX. Corps for a general retirement to the line of the La Bethune River, which enters the English Channel at Dieppe. At this time about 900 replacements arrived, which were hurried to the Bethune line for incorporation in their units. Practically all of them were to be captured within forty-eight hours. The Bethune position was not occupied until after daylight on June 9th. Exhausted as the troops were, they had to be kept at work until midday preparing for defence.

On June 9th representatives of the Royal Navy arrived at division headquarters to discuss measures for evacuation from Le Havre. An original plan to continue the retreat by way of Rouen had perforce to be abandoned, as a result of the German menace at that place and the destruction of the adjacent bridges over the Seine.

Following a hasty conference held in front of the church at Arques, orders were issued for the withdrawal of the whole IX. Corps and its attached troops to Le Havre with a view to evacuation through that port. Moreover, a tactical measure of critical urgency was ordered. This was the dispatch of a group known later as the " Ark Force," formed by hurriedly throwing together what was left of the 154th Brigade, the improvised " Brigade A," two field regiments of Royal Artillery (garrison ?) three field companies of engineers, and various odds and ends of troops, to prepare and hold a covering position in front of Le Havre. The corps was to retire behind this force into the port.

As if things were not bad enough already, on June 10th more unwelcome news came. In the first place, neither the supplies from Le Havre, nor the ammunition from Rouen, had ever materialized. G-4 must have gnashed his teeth ; but G-3 also must have had more than his share of trouble. Intelligence reports now showed beyond doubt that German tanks and motorized infantry had just turned north from Rouen and were about to cut off the retreat of the division and corps on Le Havre. On the heels of these reports came others, asserting as facts fully established that the Germans were advancing in full force on both Fécamp and Dieppe. A glance at the accompanying map will show what this meant. There was good reason to believe that the Germans' favourite scissors action was about to be applied. New decisions had to be made with utmost speed. And the staff work to put them in effect had to be efficient as well as speedy.

The only port left open to the hard-pressed Highlanders and their French allies of the IX. Corps was the small town of St. Valerie-en-Caux. The decision was to try to get away through that place. To this end orders were issued to establish a beach-head around St. Valerie, and for a withdrawal into it during hours of darkness. A

staff officer was sent to acquaint the Ark Force with the changed situation and to assist in evacuating troops in its vicinity through Le Havre.

The beach-head at St. Valerie was immediately established. June 11th was signalized by heavy German attacks against it. In these attacks the action of the German ground troops was accurately co-ordinated with that of swarms of dive-bombing planes. Nevertheless the Highlanders repelled every assault of every kind made against their sector. But unfortunately, the Germans were able to break through in the sector held by the French IX. Corps, and even to enter St. Valerie itself. The headquarters of the Highland Division had just been set up there! There was barely time for a shift of headquarters westward and closer to the beach.

During the day, orders had gone out from division headquarters to destroy all vehicles and equipment, except small arms and ammunition, and to withdraw to the beaches preparatory to evacuation.

The sorely pressed troops tried to carry out the order, but upon arrival in the night at St. Valerie they found that the town was in German hands, and there were no ships available for evacuation. It is wonderful to relate that even in this disastrous situation, order and cohesion were not lost. Some men tried to save themselves by swimming out to small craft lying off the seawall, but German machine-gun fire accounted for most of them.

The navy, finding it impossible to approach St. Valerie, had moved the British transports to Veules-les-Roses, a village four miles to the east, possibly without notifying division headquarters about the change. A few of the more fortunate men who were trying to escape individually managed to reach the transports.

Daylight of June 12th disclosed a glorious but pathetic sight. The remnants of the gallant division were occupying a final position on the beach, still defiant, although the Germans had captured the town, and no boats for evacuation were in sight. The Highlanders' plan at that time was to hold out until night, then either to recapture the town or move elsewhere in the search for boats. No doubt they would have done one or the other, had either been humanly possible. But though troops can continue to fight without food, they cannot oppose a completely equipped enemy without ammunition. And for the Highlanders both food and ammunition were lacking. Dauntless as they were, the survivors were therefore compelled to surrender.

Nevertheless, this splendid Highland Division did not suffer a complete eclipse. What was left of the Ark Force, after covering the evacuation of other forces at Le Havre, succeeded in getting away, the last elements embarking at Le Havre at daybreak on June 14th.

BITUMINOUS SOIL STABILIZATION.

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

THIS paper will give an outline of the method for the design of stabilized soil foundations for road and similar purposes, as evolved by the Research Laboratories of the Group with which the author is employed.

General Considerations.

Any soil surface, whether a heavy clay or a sand or any intermediate type, possesses at a certain range of moisture content a stability that will allow it to carry limited traffic satisfactorily. Hence, the main idea underlying soil stabilization is the retention of the moisture content of the soil within such limits as will ensure stability. These limits are different for various types of soil, for the stability of a soil is governed by other factors in addition to that of moisture content. Investigations into the mechanics of soils have shown that stability is determined by :—

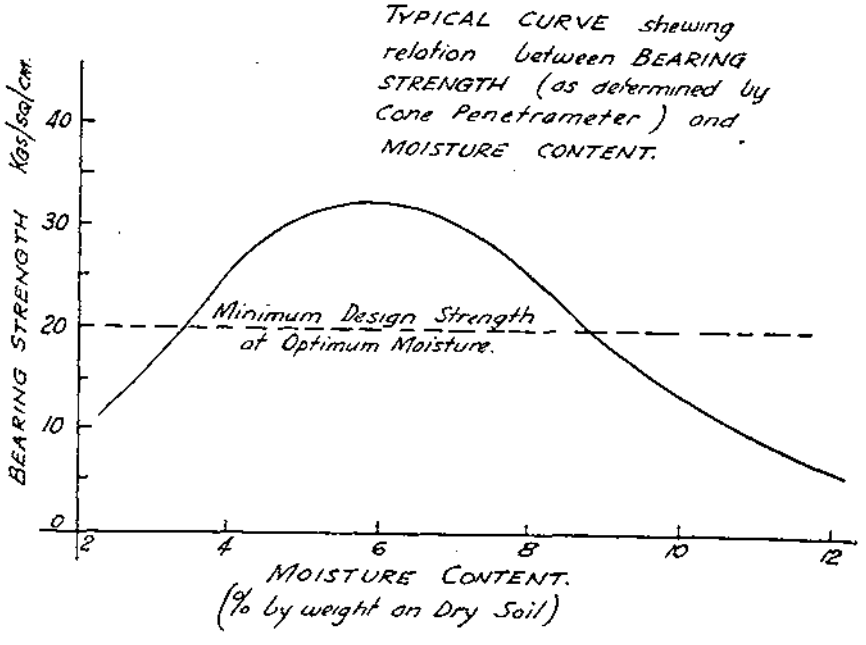
(*a*) Internal Friction.
(*b*) Cohesion, caused by the attractive forces exerted by the soil particles on each other.
(*c*) Apparent Cohesion, due to the presence of capillary forces.

In general terms, the coarser soil particles, *i.e.*, larger than 0·05 mm., consist of sand, and these develop great internal friction, whilst the finer particles, *i.e.*, smaller than ·005 mm., consist of clay, and these exhibit great cohesion. The extent to which apparent cohesion operates is governed by the dimensions of the voids in the soil, *i.e.*, its degree of capillarity, and hence not only the clay particles but also the fine soil or silt particles of size between ·05 mm. and ·005 mm., acting as a filler of the interstices between the coarser particles, greatly affect the value of the apparent cohesion. It should be added that apart from the effect of silts on apparent cohesion, they possess in themselves certain cohesive properties and exhibit low internal friction, and these properties also influence the behaviour of the soil mass.

It will thus be seen that when a soil becomes saturated with water, the apparent cohesion is lost as a result of the removal of capillary forces, and stability decreases. Stability can also be seriously affected by the evaporation from the soil in hot weather of its capillary moisture.

It is the task of the bituminous product in soil stabilization to limit these variations in moisture content, and so to retain permanently the stability of the soil. In other words, the "Apparent Cohesion" factor comes under the control of the bituminous stabilizer, and design can now be concentrated on ensuring that the stability to be so maintained is adequate for traffic requirements.

FIGURE 1



Bearing Strength.

As the measurement of stability, the bearing strength of the soil surface is determined by means of a cone penetrometer. This instrument is shown in the accompanying photograph and details of its use are given in Appendix I. Fig. 1 shows a typical curve obtained when bearing strength is plotted against moisture content, and it will be seen that there is an optimum moisture content. The permissible minimum bearing strength at optimum moisture for design purposes has been fixed at 20 kgs./cm.^{2} (284 lbs./sq. in.), and in order to obtain this minimum, it has been found that the grading of the mortar content of the soil should, in general, comply approximately with the following requirement, the mortar content being that portion passing a 10-mesh sieve :—

From 20 to 30 per cent by weight should pass the 200-mesh sieve and from 15 to 25 per cent should pass the 325-mesh sieve.

Further, the latter quantity should be at least 60 per cent of the quantity passing 200-mesh.

The material passing 325-mesh is of size less than ·05 mm., and in effect, the above limits ensure a well-balanced grading in which internal friction, cohesion and apparent cohesion will operate to give the best combined result, and which at the same time will allow of the most effective results from the stabilizer. It is obvious that only very seldom will a soil as it stands comply with this grading, and the natural soil will usually have to be modified by the addition either of sand or of clayey material. In general, it is the former modification that will be required.

The first step in design is therefore to determine the grading of the soil to be stabilized, the passing 200-mesh content being obtained by sieving, and the 325-mesh content by elutriation. Details of this test are given in Appendix 1. The grading will show to what extent the soil requires modification, and search must then be made for a local source of either sand or clayey material, as the case may be, for incorporation with the soil.

As an illustration, the case may be taken of a clayey soil which can be brought to the specified grading by the addition of a local sand, in proportion by weight anywhere between 30 and 40 per cent. Mixes would then be made of 30/70 and 40/60 sand/soil, and each mix tested for bearing strength at various moisture contents between say, 4 and 12 per cent. For each mix, bearing strength is then plotted against moisture content, and the mix giving at its optimum moisture the highest bearing strength would in the ordinary course be chosen, although the mix with a lower maximum bearing strength could be adopted if it involves a lower proportion of sand and hence less aggregate to import to the site, subject always to this bearing strength being above 20 kgs./sq. cm.

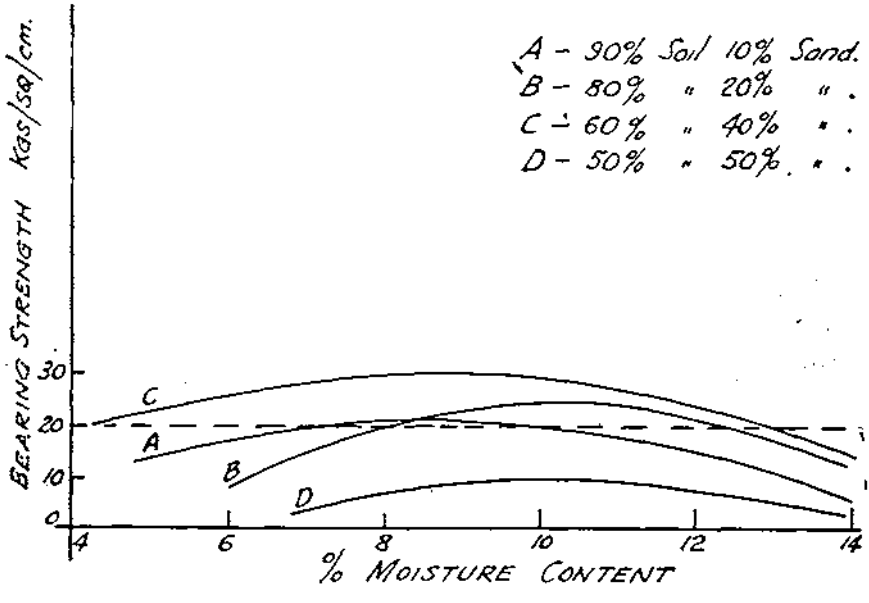
It may sometimes be found that a higher maximum bearing strength is obtained from a grading that falls well outside the specified limits than from a grading within these limits. Generally, however, a grading well within the limits will show a maximum bearing strength of over 20 kgs./sq. cm., and it is then probably not worth while adopting the grading that gives a still higher bearing strength if it necessitates bringing to the site larger quantities of imported aggregate. Moreover, such a grading may not provide the best effect from the stabilizer. It can here be emphasized that whilst the grading limits are more of the nature of a guide than a hard and fast specification, the stipulation that at least 60 per cent of the material passing 200-mesh should pass 325-mesh is of importance in order to ensure sufficient real fines (silt and clay) in the mix, and so avoid relatively wide pores that readily absorb water.

Figs. 2, 3, 4 and 5 show bearing strength curves on four different soils, each mixed with varying proportions of sand. Grading figures

for these soils and sands, and the various mixtures will be found in Appendix 2.

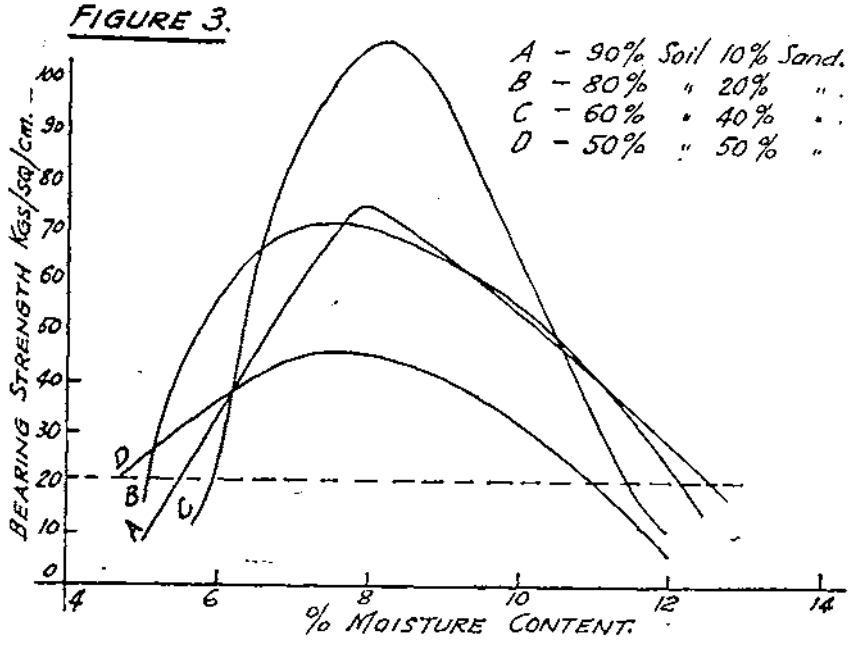
As regards Fig. 2, the very flat nature of all the curves will be noted, implying retention of a more or less uniform stability over a wide range of moisture content. The soil in question is from the grounds of one of the laboratories, and was used for a trial area of soil stabilization in those grounds in combination with 40 per cent sand (Curve C). This mixture complies with the grading limits in every respect.

FIGURE 2



The soil represented in Fig. 3 shows in all the mixes with sand a much higher maximum bearing strength than does the previous soil, but all the curves are much steeper, and show appreciable falling-off in stability as moisture content increases and decreases in respect of the optimum. This soil is an example of a case in which higher stabilities are obtained with gradings that fall well outside the suggested limit of 20/30 per cent passing 200 than with the grading of a mix, represented by Curve D, that more nearly approaches this limit. Curve C represents the mix used in another trial, and it was chosen, after checking the water-resistance imparted by the stabilizer, partly because of its high stability, and partly because it involved importing a lesser quantity of sand than did the mix (Curve D) that more nearly complied with the grading limits.

Fig. 4 relates to a loamy sand, which in itself just falls within the grading limits, but has a maximum stability of only 10 kgs./sq. cm. This soil was tested in admixtures with small percentages of two clay soils, and it is interesting to note how one of these clays is much more effective than the other in increasing the stability of the original soil. It will be seen that adequate maximum stability is obtained in the mixes represented by Curves B and C, and both these mixes have gradings within the suggested limits. Curve D shows a mix of still higher maximum stability, obtained by the use



of 20 per cent imported clay soil as against the 10 per cent of Curve C, but there would be little point in importing this larger amount when the lesser is adequate.

Fig. 5 represents a more or less clean sand stabilized with a brick clay. The grading of the mix is just within the suggested limits, and the maximum stability is more than adequate.

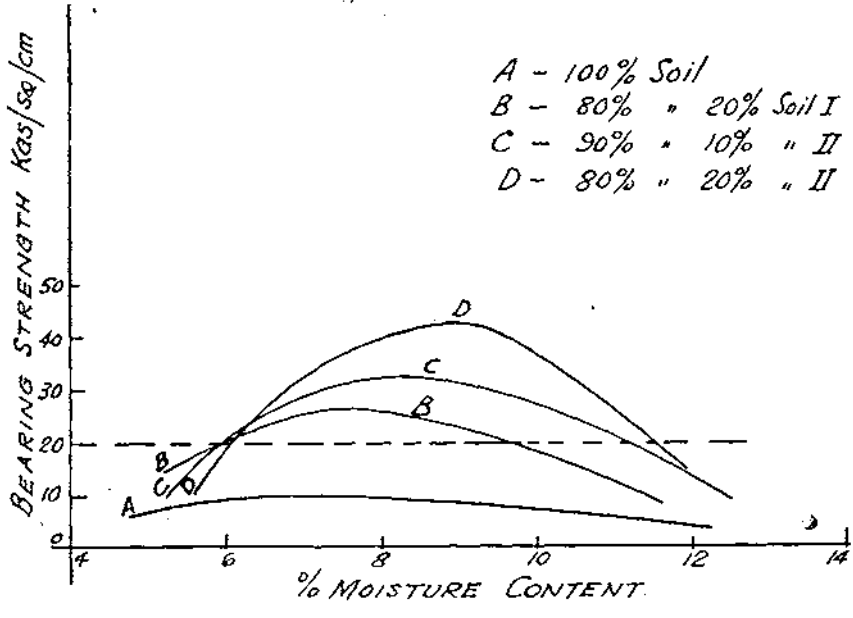
The grading and stability tests are the only mechanical ones that are needed in this method of design, and before passing on to the question of the bituminous stabilizer it should be noted that, in general, bearing strengths as determined by the cone penetrometer test are not affected by the presence of this stabilizer, and hence, these tests are done on samples prepared without the stabilizer.

Function of the Bituminous Stabilizer.

As has been said, it is the task of the stabilizer to impose a limit to the variations that could occur in the soil mass as regards moisture

content, by reason of ingress of capillary or of ground water. It was rational to assume that a bituminous stabilizer in a soil of adequate bearing strength (within certain limits of moisture content) is not required to function as a binder, coating all or some of the soil particles, for the stability of the soil could quite well be left to its inherent characteristics, as governed by internal friction, cohesion and apparent cohesion. It was therefore argued that, given a soil which with a suitable moisture content has adequate stability, the bituminous stabilizer should be of such a nature that it can be dispersed throughout the soil mass in such a way as to form automatically a series of plugs throughout the capillary structure of the

FIGURE 4.



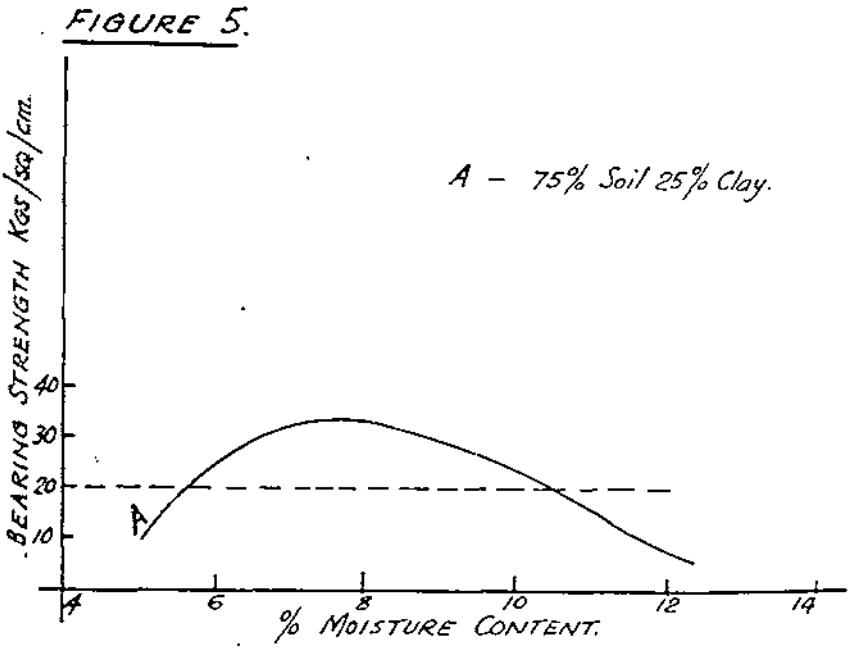
soil. These plugs must remain permanently in position, resistant to washing-out by ground water or to displacement by capillary forces, and thus prevent the ingress of further moisture.

Water Resistance Test.

The test in this design method by which the effect of bituminous products on the water resistance of a soil is judged is one of a capillary rise nature. The suitable soil mix, as determined by the grading and stability tests, is brought to a moisture content of 10 per cent and mixed with the required amount of the bituminous stabilizer. It is then moulded into small cylindrical test pieces, which after a standardized pre-treatment, including waterproofing of the curved

surfaces, but not the ends, are placed on end on a bedding of wet sand in a closed tank. The progress of water absorption by capillary rise is determined from the changes in weight after 1, 3, 7, 14 and 28 days, and provided this water absorption keeps within certain established limits, it can be taken that the stabilizer is acting effectively.

As a result of research, a highly effective stabilizing oil would seem to have been evolved, and the following figures show, as an example, test results on samples treated with an ordinary road oil



and samples of the same soil mix treated with the same percentage of the special stabilization oil.

	Water absorption (in grams) after				
	1 day.	3 days.	1 week.	2 weeks.	4 weeks.
Road oil	21·7	22·3	24·5	Sample collapsed.	
Stabilization oil ..	3·0	3·0	3·5	3·5	7·0

As a practical example of the efficacy of the stabilization oil in providing water resistance, samples of stabilized soil from the trial area to which Fig. 2 refers were taken in December, 1940, and tested for moisture content. Simultaneously, samples were taken of the natural soil immediately beneath the stabilized layer, and similarly tested. The stabilized soil showed a moisture content of about 5 per cent, whereas the underlying soil gave a figure of over 30 per cent, as would be expected from the water-logged state of the ground.

Further, there was an absolutely clear line of demarcation between the stabilized soil and the underlying soil.

The figure of 5 per cent moisture in the stabilized soil is somewhat lower than the moisture content of the mix at the time of laying in June, 1940. The aim then was to mix at a moisture content of about 8 per cent, but the work was done in hot weather and with the more or less improvised methods employed, difficulty was experienced in maintaining the moisture content of the mix, when spread and whilst awaiting consolidation.

Amount of Bituminous Stabilizer.

As regards the quantity of stabilization oil required, it has been shown in the laboratories that a soil mix, designed in accordance with the grading and bearing strength requirements and containing 2 per cent by weight of stabilization oil, possesses in general adequate water resistance. Still greater resistance can be obtained by the use of 3 per cent of the oil, but an increase above this amount does not seem to be technically necessary, nor justified from the standpoint of cost. In other words, and this is an important factor as regards the amount of laboratory work that would be necessary in the field, a well designed mix as regards grading and bearing strength, with 3 per cent of the stabilization oil, can be assumed to be of adequate water resistance, and it would not be necessary in the field to carry out the capillary-rise test.

The percentage of the oil is based on the mortar content of the mix, *i.e.*, the passing 10-mesh material, and in the case of a mix containing—as is usual with soils—some aggregate, such as gravel, larger than 10-mesh, some arbitrary allowance should be made for possible oil absorption by this aggregate. This allowance could be from 0·5 to 1·5 per cent, depending on the size of the coarse aggregate; the smaller the aggregate, the higher the amount of oil. For instance, with a soil of grading 20 per cent retained 10-mesh (80 per cent passing 10-mesh), the required amount of the oil would be from 0·5 to 1·5 per cent of 20, plus 3 per cent of 80.

Frost Resistance.

Being assured of bearing strength and water resistance, the stabilized soil must also possess resistance to the effects of freezing, in the case of countries where frost conditions are encountered. The test used for checking frost resistance is one in which small specimens of the soil mix, incorporating the required amount—2 to 3 per cent —of the stabilizing oil, are subjected, after standardized pre-treatment, to six cycles of alternate freezing and thawing, during which they are kept under occasional observation to ascertain the extent to which they fall to pieces, crack, soften or remain intact.

Given compliance with the design factors already dealt with, *i.e.*, grading, bearing strength, and water resistance, the position as

regards the frost resistance imparted by the stabilization oil seems to be, from laboratory work, that it is automatically obtained, and hence, there is no need for this test to be carried out. It is, however—like the capillary rise test—a useful one to carry out for check and record purposes in a fully organized laboratory not operating under field conditions.

Some Notes on Road Methods.

Apart from trial lengths in this country and abroad, and several small areas abroad laid on a practical scale, there has yet been no opportunity to carry out soil stabilization work based on the design method just described. However, this method involves no departure, so far as actual working procedure is concerned, from the methods of mixing, spreading and consolidation employed in the U.S.A. for soil stabilization, and hence, it can be put into practice by the mix-in-place method, by means of a road travel-mixer or by mixing at a central plant.

Mixing.

As regards the incorporation of sand into clayey soils, experience so far shows that provided the clay soil has sufficient moisture to be "workable," the sand can be more or less uniformly incorporated in it by mixing, together with the stabilization oil heated to 150°/200°F., in the usual twin-shaft paddle type of mixer for about two minutes. There may be a number of small clay balls that have not broken down and taken up the sand, but these would not be detrimental unless present in obvious excess, for during compaction, some of them would break down and the rest would be dispersed throughout the stabilized layer, each surrounded by properly stabilized soil.

If the clay soil to be used were baked hard, as would possibly be the case during a long spell of hot dry weather, the best procedure would probably be to scarify it and break it down as far as possible with harrows and by rolling, and then to feed this pulverized soil and the sand to the mixer, add the required quantity of water, and after a preliminary mixing period, the stabilization oil would be added and mixing continued.

By the grader mix-in-place method, the breaking down of moist clay pellets and the uniformity with which the sand can be incorporated will not be so good as in plant-mix, but judging from American experience, it seems that this method can be made to give sufficiently good results.

Consolidation.

The question of consolidation of the mix is an all-important one. In theory, the idea is to consolidate at optimum moisture content

of the mix, so that once consolidation is effected, the mix retains permanently this moisture content within narrow limits of variation, and so maintains its stability. It is obvious, however, that practical requirements cannot be tied to a consolidation that has to be effected at a definite moisture content, and that some latitude must be available.

Referring back to Fig. 1, it will be seen that whilst optimum moisture content occurs at about 6 per cent, the range over which the bearing strength for this particular soil of minimum 20 kgs./sq. cm. is maintained lies between about $3\frac{1}{2}$ per cent and 9 per cent moisture. This means that if consolidation is effected at any moisture content within this range, the surface will have a more than adequate bearing strength. In work done during a rainy spell, the soil would already contain appreciable moisture and would take up further moisture during mixing and spreading. As a result, the mix when laid would quite likely be above the 9 per cent moisture content, and hence would have a bearing strength less than 20 kgs./sq. cm. It might for instance have 11 per cent moisture, giving for this particular soil a bearing strength of about 10 kgs./sq. cm. (140 lbs./sq. in.) and this would be adequate for most traffic requirements. If therefore it were necessary to consolidate at once, it would be safe to do so, and there would be no need to wait for a day or two of fine weather to dry out the mix from 11 per cent to 9 per cent or less moisture content.

In dry weather, it would be advisable to try to effect consolidation at a moisture content above rather than below the optimum, because the surface in an open state will tend, whilst waiting consolidation, to lose by evaporation a certain amount of moisture, and hence a mix with a moisture content, when laid, somewhat below optimum may, by the time consolidation begins, be too dry to be amenable to proper consolidation.

Required Thickness.

The required thickness of a stabilized soil foundation depends, of course, on the nature and intensity of the traffic that it will have to carry and the supporting power of the sub-soil. The thickness may therefore be anything from 3 in. to 10 in., but in general, 6 in. to 8 in. should be sufficient.

Wearing Carpet.

Whilst the stabilized soil surface would be resistant to rain or standing water, it is not resistant to the mechanical effect of traffic in combination with such water, nor to the abrasion of traffic. Further, in hot weather, the surface would lose by evaporation a certain amount of its moisture content, and become friable. Hence, a stabilized soil layer always requires an impervious wearing carpet, and the choice of the type of carpet is governed in the usual way

by local circumstances and the requirements of the traffic that has to be carried. The carpet might therefore be an ordinary surface treatment, or an armour coat, or bituminous or tar macadam, or sand mix (as done in Egypt with dry sand and in this country with wet sand), or one of the hot-mix asphalt types.

Potentialities of Soil Stabilization.

It is not of course claimed that the method of design described in this article is one that has definitely proved itself, for such a claim could not be made on the strength of the limited experience that is at present available. It can, however, be said that the method does seem to hold promise of success. Again, it will be understood that this design method relates to one way of carrying out bituminous stabilization, and that there are other ways.

The potentialities of soil stabilization are very considerable, and there is little doubt that in due course it will establish itself, in some or all of its several possible forms, as a method for building foundation courses for road and similar purposes in the civilian sphere. The merits and the cost of that method will then be weighed against those of the present methods of foundation construction in arriving at a decision as to the method to employ in each particular case.

As is so frequently the case with new methods, military requirements may accelerate the development of soil stabilization, for the question of the amount of aggregate that has to be brought to the site, and hence, the amount of transport required probably assumes far greater importance in military than in civilian work. From this standpoint, soil stabilization would in general show to advantage. Taking the case of a soil that requires the addition of sand (or other granular material) in the proportion by weight of 30 per cent sand to 70 per cent soil, the amount of sand required for 10,000 sq. yds. of stabilized soil, of 6 in. consolidated thickness, would be about 800 tons. In addition to this imported material, there would be required, on the basis of the design method described, about 80 tons of the stabilization oil, and, assuming the wearing carpet to consist of an emulsion surface treatment, about 20 tons of emulsion and 100 tons of chippings. Hence, the total weight of material to be transported to the site would be about 1,000 tons, for the 10,000 sq. yds.

As to the extent to which this way of stabilizing soil is dependent during construction on dry weather conditions, in order to obtain in reasonable time the required drying-out of the mix to such moisture content as will ensure stability, there will be no difficulty in this respect under European spring, summer and autumn conditions, for it will be found in most cases that the natural moisture content

of the mix falls close to or within the required limits for stability. In winter, however, the natural moisture content of the mix will generally be above the desired maximum limit, though not to any very appreciable extent, and it is probable that two or three days of dry weather would be sufficient to reduce the moisture content sufficiently to permit consolidation to be effected. Alternatively, there are possible methods, which it is hoped to investigate, of artificially drying out the mix so as to overcome this winter difficulty. Even so, a greater problem under winter conditions would seem to lie in the operation of the equipment on the actual site of the work, for this would be turned into a morass in a very short time. This problem, however, could possibly be solved by working from a central mixing plant adjacent to the site, and transporting and spreading the mix in such a way that traffic on the formation is reduced to an absolute minimum.

APPENDIX I.

DETERMINATION OF BEARING STRENGTH BY CONE PENETROMETER.

When a loaded cone is allowed to bear vertically upon the surface of a soil, penetration will occur to a depth dependent on the load bearing capacity of the surface. A 45° cone is used (*i.e.*, 90° total angle), and hence " d," the depth of penetration, is equal to " r," the radius of the cone at the level of the original surface of the specimen. Therefore

$$\text{L (load bearing capacity)} = \frac{W}{\pi d^2}$$

where W is the total weight of the cone assembly (*i.e.*, the cone, its rod and weight pan) and any superimposed load. The former is usually about 5 kgs. (11 lb.) and the latter about 16 kgs. (35 lb.).

In carrying out the test, the point of the unloaded cone is placed in contact with the surface of the specimen. The cone is then loaded and allowed to penetrate, and when equilibrium is reached, the depth of penetration is read on the scale attached to the penetrometer. The load bearing capacity usually increases with time up to 24 hours after the specimen has been prepared, and hence if time permits it is as well to carry out the test at the end of that period.

In preparing a test specimen, a cylindrical steel mould, 15 cm. (6 in.). diameter and 12 cm. (about 5 in.) deep is used, into which the soil is compacted in three layers of equal thickness, the compaction being effected by covering the surface with a 15 mm. ($\frac{5}{8}$ in.) steel plate, and allowing a 5 kg. (11 lb.) weight to drop on the plate thirty times from a height of about 60 cm. (24 in.). The lower end of the mould should rest

on a steel base plate, and when the specimen is ready for testing, the mould on its base plate is placed in position on the penetrometer.

The method of compaction adopted is such that it agrees very well with the consolidation obtained in practice. The weight of material in a test specimen is about 2 kgs. (4½ lb.). In the absence of steel moulds, stoutly constructed wooden boxes of suitable size could be used.

For work in the field, it is suggested that sufficient of the soil mix should be prepared to make five specimens, each in its own mould and of respective moisture contents 4, 6, 8, 10 and 12 per cent. A total of about 12 kgs. (25 lb.) of the soil mortar is therefore required, *i.e.*, of material passing 10-mesh, as chippings or stone particles must obviously be excluded from the test specimens. If the natural soil can be used as it stands, a representative sample should be taken of such weight as to give about 12 kgs. after eventual screening through a 10-mesh sieve, whilst if the soil has to be mixed with sand or clayey material, representative samples of the constituents should be taken in the required proportions to give a total of about 12 kgs. of the mix, all passing 10-mesh.

The sample or samples should then be broken down as far as possible and spread on a tray for drying in an oven, using a separate tray for each sample. The oven has to be able to maintain a temperature of about 100°C., and it can easily be improvised, *e.g.*, from a biscuit tin and a primus stove.

After complete drying, each sample should be roughly broken down so as to permit of easy screening-out of individual particles over 10-mesh size, all subsequent work then being done with the passing 10-mesh material.

Each sample, except in the case of sand, is then ground by pestle and mortar to as fine a condition as possible. In the case of a sample representing a soil that requires no added sand or clay material, the sample after grinding is divided into the five equal portions, and to each portion is then added the required amount of water to give respectively 4, 6, 8, 10 and 12 per cent moisture content, these percentages being on the dry soil. For instance, 1,000 gms. dry soil would require 40 gms. (*i.e.*, 40 cc.) of water to give 4 per cent moisture content.

In the case of a sample that requires added sand or clay material, the mixing in the required proportion of the two constituent dried and ground samples is done by thorough hand stirring, and the procedure then follows that of the preceding paragraph.

In order to obtain the necessary uniform dispersion of the water throughout the soil mortar, very thorough hand mixing is required. Immediately this mixing is finished the mix is transferred to the mould, and consolidated in the way already described. If it is to be left 24 hours before testing, then the exposed surface of the specimen in the mould should be covered to prevent evaporation loss.

Elutriation Test.

This is carried out on a 1,000-gm. sample of the soil mortar content of the soil, *i.e.*, passing 10-mesh material. A representative sample of

the soil should be taken in quantity sufficient to give this amount of soil mortar, and should be oven-dried and then broken down so as to be able to screen out easily the sand, chipping and stone particles larger than 10-mesh. 1,000 gms. of the passing 10-mesh material are taken and placed in a circular pan, of diameter 25 cm. (10 in.) and height 10 cm. (4 in.). Water is added until the level is within 1 cm. ($\frac{1}{2}$ in.) of the top of the pan. The water is then stirred by hand for 15 seconds with a linear (not circular) motion, and allowed to settle for another 15 seconds. The water is then decanted off through a 200-mesh sieve, all material retained on the sieve being returned to the pan. This procedure is repeated till the washings come off clear. The material retained in the pan is oven-dried and weighed, and the percentage which has passed off with the water, *i.e.*, the passing 325-mesh material, calculated from

$$\frac{\text{Loss in weight} \times 100}{\text{Original weight.}}$$

Should a 1,000 gm. quantity be found difficult to handle, owing to the ratio of soil to water being so high as to interfere with easy settlement of the larger particles, then a 500-gm. or even 250-gm. sample may be used, but the smaller the sample the greater the care that should be taken to ensure that it is representative. With these smaller samples, decanting-off through a 200-mesh sieve is still advisable.

After oven-drying and weighing the material left in the pan, it should be thoroughly mixed and 100 gms. of it taken for sieving through a 200-mesh sieve.

To give an example, assume weight of material retained in elutriation pan is 800 gms. and the original weight of sample 1,000 gms. The passing 325 material then represents 20 per cent of the original sample. 100 gms. of the material left in the pan, on sieving through the 200-mesh sieve, give say 5 gms. passing, 95 gms. retained. Hence on the 800 gms. there would be 40 gms. passing 200, which represents 4 per cent on the original 1,000 gm. sample. Hence the grading of the soil mortar is :—

Passing 325	20%
Passing 200 retained 325	4%
Retained 200	76%

It should be noted that the amount of soil mortar must be enough, or more than enough, to fill the voids between the coarse particles (*i.e.*, retained 10-mesh) that are present in the soil to be stabilized. This point really only arises in the case of a gravelly or stony soil, for in most soils the amount of stone material present will be such that the stone particles do not act as an interlocking system but are distributed here and there throughout the soil mortar.

APPENDIX II

FIG. 2.

	Soil.	Added Sand.	90% Soil, 10% Sand.	80% Soil, 20% Sand.	60% Soil, 40% Sand.	50% Soil, 50% Sand.
Passing 325 mesh ...	32%	–	28%	25%	19%	16%
,, 200 ,, ...	15	4%	14	13	11	10
Retained 200 ,, ...	53	96	58	62	70	74
Curve			A	B	C	D

FIG. 3.

Passing 325 mesh ...	59%	–	53%	47%	35%	30%
,, 200 ,, ...	5	4%	5	5	5	5
Retained 200 ,, ...	36	96	42	48	60	65
Curve			A	B	C	D

FIG. 4.

	Soil.	Added Clay, Soil I.	80% Soil, 20% Soil I.	Added Clay, Soil II.	90% Soil, 10% Soil II.	80% Soil, 20% Soil II.
Passing 325 mesh ...	16%	29%	19%	75%	22%	28%
,, 200 ,, ...	6	14	8	5	6	6
Retained 200 ,, ...	78	57	73	20	72	66
Curve	A		B		C	D

FIG. 5.

	Soil.	Added Clay Soil.	75% Soil, 25% Clay.
Passing 325 mesh ...	–	75%	19%
,, 200 ,, ...	3%	5	3
Retained 200 ,, ...	97	20	78
Curve			A

Suggestions.

The Play.

(i) If there are too many players, the audience lose track of who is who. Not more than six is a good guide.

(ii) The majority of the players should have fairly equal parts. A play with a " star " part who does all the talking approximates too closely to a lecture !

(iii) Speeches should generally be short. A three-sentence speech is sufficient to contain meat, but is short enough for the whole to be borne in mind during any comment that follows it.

(iv) Name in a speech, at its beginning, the person to whom it is addressed. In this way no reliance is placed on the acting to make clear to whom the player is speaking. (This may make the dialogue a little untrue to life, but it is worth it.)

(v) Beware of character-drawing. It demands a high standard of authorship, and is not usually necessary. It may, of course, help to point a moral if a character is noticeably thick-witted, or slap-dash, or anything else, but do not character-draw for the sake of so doing—even though it is an amusing occupation !

(vi) It will be found in writing plays that side-issues spring up in surprising numbers. Keeping to the point is a virtue here as elsewhere.

(vii) The finished product should be clear-cut and its lessons obvious, and so to write a good play takes time. Priming and polishing is, however, quite an entertaining occupation for any spare quarter of an hour.

The Commentary.

(i) The remarks of the commentary should be short and crisp, so as to interrupt the sequence of the play as little as possible.

(ii) The best place for a comment is at the end of a speech. After a comment, the last player to speak should repeat his last sentence to restart the play. This helps the audience to pick up the thread.

The Setting.

(i) By judicious arrangement, tables and chairs can represent anything. A table-top, supported on end and bearing DUG-OUT chalked upon it, once served excellently as such. When entering it, a player merely retired discreetly from view.

An instructor's announcement alone will often serve. Thus, if he says, " The setting is a dirty night in Salisbury Plain country," imagination should not be over-taxed.

(ii) If a property is required, the genuine article adds realism, but time need not be wasted seeking it. For example, any handy item such as a glove can serve as a telephone, and so on.

(iii) " Off-stage " and " on-stage " should be defined by pieces of furniture, and the former must be inside the classroom, so that nobody loses anything by performing an exit which takes him out of the room.

The Players.

(i) These should each bear a large label to show whom they represent, or alternatively they may be defined by a property. Thus, a D.R. might be indicated by either a label or a pair of goggles, but whichever it is, it must be obvious.

(ii) Explain to the performers beforehand about the pauses for the comments, and then tell them that, except for such pauses, they must pick up their cues quickly. This makes all the difference between a live and a dead performance. (In the theatrical world it is one of the prime differences between professional and amateur acting.)

(iii) The players must at least be able to read fluently and clearly. The higher the intelligence of the class, the more is a play worth doing. It is hardly worth attempting one with slow-moving brains. On the other hand, instruction for the unintelligent can be made much more vivid by play-acting than by speech alone, but the performers should be found from outside the class.

The sample play which follows was written for Officer Cadets who were found regrettably ignorant of what is meant by G, A and Q. Hence this glimpse of a Staff at work. It was found that various bits of information subservient to the main purpose crept in, but they were not weeded out as they served as useful revision.

A Corps H.Q. was chosen, as the Class were all destined for Corps Troops units.

This play makes no claim to being a model, but it proved successful in practice and serves as a fair example.

THE STAFF.

AN INTRODUCTION WITHOUT TEARS.

(Numbers in text refer to the Commentary.)

Scene.

Office of the B.G.S. at a Corps H.Q. ; time, 0930 hrs. on the 20th of the month. The daily *G* Conference is in progress. Those present

will already have been in their own Offices, so that they arrive at the Conference quite up to date.

The Corps is part of a B.E.F. operating with our Allies, the RURITANIANS, in their country. Operations are in a somewhat static state, but more active operations are planned.

On this occasion the Senior Officers of each department are present. They may often be unable to attend in person, in which case they send one of their Staff Officers to represent them. There is a calm, friendly atmosphere, conducive to good team work.

Present.

	Referred to below as :
B.G.S. (in the chair)	B.G.S.
G.S.O.2 (O)	G. (O)
G.S.O.2 (I)	G. (I)
D.A. & Q.M.G.	A/Q.
C.C.R.A.	R.A.
C.E.	E.
C.S.O.	Sigs.
Senior Officer of RURITANIAN Mission (1) ..	Mission.

B.G.S.: I have no change of situation or plans to tell you, but there is the question of the new ammunition dump at the Brick Factory in BRICKBAT.

Q., I know you have objections to the site, but unfortunately the alternative you mentioned does not fit in with operational needs. (2)

We shall want X tons in it, and it must be ready to receive ammunition at the rate of Y tons per day, starting on the 26th. Those are the figures which have been fixed in consultation with R.A. Now about Q. difficulties, which arise because the site is away from the railway.

A/Q.: Yes, that is a pity. Transport as usual is not so plentiful. However, C.E. tells me he can help with a light railway. (3)

C.E.: I looked at the various possible sites you mentioned and BRICKBAT doesn't seem to be the worst. I have roughed out a scheme for it. (*Produces a sketch plan.*) (4)

I have taken up for a light railway within the dump, and it is possible to extend it as far as the siding by CHUFFAR railway station. The snag is that I have only sufficient track for use within the dump, and I cannot get any more from the Base for some time. There is, however, nearly a mile not in use at SUTTY coalmine. The manager of the mine was sounded and says the mine itself will want it all soon—but from the look of the place my I.O. says he doubts this. (5)

B.G.S.: I think the Mission might help us there. (6)

Mission: Certainly. The *Agent de Liaison* with the C.E. has tech-

nical knowledge but is a little scared of people like mine managers, so I'll deal with it myself. May I have an R.E. officer to go with me?

E.: Of course, though I have checked up on the technical side, the gauge is correct, and so on. . . . I'll let you know as soon as we have arrived at our exact requirements.

B.G.S.: We must consider the concealment question. Have G. (I) had aerial photographs taken yet? (7)

G. (I): Weather permitting, they are being taken to-day. G.3 (Air) has seen our Co-op. Squadron. (8)

E.: The Corps Camouflage Officer will want to look at them as soon as possible. I have shown him the rough sketch of the dump, and he is hatching a scheme. (9)

G. (I): There is also the Security aspect. The inhabitants of BRICKBAT are a doubtful lot.

B.G.S.: All concerned, please note that. We cannot attempt to conceal our activities there altogether, but there is no reason why we should give away their nature for some time, anyway.

A/Q.: I'll go into detail requirements with D.D.O.S. Size of stacks, spacing, and so on, and pass on to the C.E. details of what we fix. (10)

E.: Here's a duplicate of the sketch plan on which the required layout can be put. Then we can get on with construction. There are one or two engineer snags. The shaded area, for instance, is difficult, as the inclines would be too steep for the light railway. (11)

A/Q.: Right. D.D.O.S. is coming to see me at 1030 hrs.—perhaps the C.E. will join us?

E.: I'm afraid I can't manage that, but I'll send my S.O. who is in the picture. (12)

I can foresee a good deal of work on this job, and we haven't the Sappers to spare. Can I have a company of Pioneers for ten days, starting the day after to-morrow? (13)

I'll find a section from a Field Company of the Corps Troops to work with them. (14)

G. (O): There is that Company of the Loamshires doing guard duties on the dump at PARKY. It was arranged for them to be relieved to-morrow, returning to their Battalion. All the other Pioneers have some definite commitment. (15)

B.G.S.: I'd like them to rejoin their Battalion, but in the circumstances I am sure the Corps Commander will agree to their being put under command of C.E.

G. will confirm that in writing by a definite order. (16)

E.: I'd like to have them on the spot.

A/Q.: Not so easy. There is not much accommodation at BRICKBAT and it's full of Corps Troops, R.A. (17)

E.: It is important to have them close to the job. We do not want to waste time and petrol coming and going, and also of course the Pioneers have so little transport of their own. (18)

A/Q.: What about shifting that Battery at the old laundry at BRICKBAT? We could fit it in at BLANQUE.

R.A.: I don't like the idea. They have been shifted round quite a lot already. However, it will hardly affect us operationally. (19)

B.G.S.: Right, that's fixed. Moves to take place to-morrow. Detail arrangements left to Q. Has anybody any further points?

Sigs.: We find the strain on D.R's rather heavy, partly because there are a lot of calls for Special D.R's. As the D.R.L.S. is working smoothly, perhaps they can be reduced. May I remind everybody that any officer, visiting a formation, can help us by calling at the Signal Offices each end when both going and returning.

B.G.S.: Everybody must be prepared to help Signals by playing the part of a D.R. whenever going between the various H.Q's and Units. See that all officers realize that. One further point—A.D. Survey is going well towards meeting our present map needs, but Survey are also working hard in connection with future operations. So use maps economically. (20)

That's all, thank you.

CURTAIN.

SCENE II.

Office of D.A. & Q.M.G.

Time: 1030 *hrs. on the 20th of the month.*

The Q Conference is held after the G Conference, the function of A/Q. being to implement administratively the operational policy.

Between the Conferences, D.A. and Q.M.G. has had a chat with A.Q.M.G.; D.D.S. & T. and D.D.O.S. have probably already received some advance information about the new ammunition dump. Often meetings such as this are merely "co-ordinating conferences."

Present.

	Referred to below as:
D.A. & Q.M.G.	A/Q.
D.A.A.G.	A.
A.Q.M.G.	Q.
S.C.R.A. (rep. C.C.R.A.)	R.A.
C.R.E. Corps Troops (or his Adjt.)	C.R.E.
S.O.R.E. (rep. C.E.)	E.
D.D.S. & T.	S. & T.
D.D.O.S.	O.
D.D.M.S.	Medical.

A/Q.: The new Corps ammunition dump is to be at the Brickworks at BRICKBAT, and will finally contain X tons. Ammunition is to start arriving on the 26th at the rate of Y tons per day.

Have S. & T. got delivery arrangements in hand ?

S. & T.: Yes, we can manage that rate of delivery all right. (21)

A/Q.: After this Conference I want to go into the detail layout with O.

I understand that S.O.R.E. knows about the E. side. We will want him, too.

One Section of a Field Company and one Company of Pioneers now at PARKY are to move to-morrow to BRICKBAT for 10 days to prepare the site. I expect the C.R.E. has already heard about that. (22)

C.R.E.: Yes, I had a warning order yesterday and confirmation through S.O.R.E. half an hour ago. I shall send a Section from 99th Field Company now at SPAYDE. What about accommodation ? (23)

A/Q.: A.Q.M.G. will give you details afterwards, and will have to tell the Pioneers also. (24)

Q.: Right, sir. As that Battery is going out, the Sappers and Pioneers will be all right for accommodation. By the way, I believe that particular Battery is below strength at the moment —though reinforcements are expected.

A.: Yes, that is so. All their first reinforcements are coming up. Expected to arrive the day after to-morrow. (25)

Q.: Then I'd like to see the S.C.R.A. after this Conference about accommodation for the Battery at its new location.

I believe the Gunners had some water difficulties at BRICKBAT ?

R.A.: Yes, sir—at the old laundry, where the supply is poor, and there are no proper ablution arrangements. The Sappers are working on it now.

A/Q.: Well, no doubt the Sappers will finish it off when they get there themselves and, of course, see to the needs of the Pioneers also.

C.R.E.: One of my Field Engineers has been making a water reconnaissance and the local supply is not plentiful. However, it will meet our needs and I am having a meeting with the Village Bignoise this afternoon to reassure him that our requirements won't disturb the local inhabitants.

I'd like Medical to examine the water from the old well which we have discovered there. If the quality is all right, it should give a useful yield.

Medical: Give me its exact location afterwards and D.A.D.H. will arrange for it to be tested. (26)

A/Q.: About the move of these units. Sappers and Gunners are all right, but the Pioneers will want help. They won't have time to

march. Can we help them from the reserve M.T. Company? (27)

S. & T.: Yes, easily, if it is only one Company to be moved. I'll get D.A.D.T. to see A.Q.M.G. about exact transport required later this morning.

A/Q.: Earlier the better as we must let the Pioneers know. That is all for that. Anything else?

A.: There are several Court-Martial cases, apparently due to wild driving, just coming up, sir.

A/Q.: There have been too many cases like that recently. There will be a tightening up on discipline in that respect. You will see a paragraph about it in Corps Orders, and I am going to tell the A.P.M. to see that the Redcaps watch out for it. I shall call for a report from him about it later. (28)

Last point, D.A.C.G. moaned to me that he has not been given an up-to-date copy of the location list of Corps Troops. "A" Branch are to see that he gets one. He can't watch over the spiritual needs of units if he does not know where they are.

That is all, thank you. (29)

CURTAIN.

COMMENTARY.

1. The Mission probably consists of sufficient representatives for one to be attached to each large Unit. Many of the *Agents de Liaison* possibly hold ranks equivalent to W.O's but are treated by us as officers. They are chosen because they can speak English, and are allotted to Units according to their technical knowledge, if any.

2. Operational needs always come first. It is the duty of the Administrative side to fit in with them, but of course *G* must bear in mind the *Q* side when making plans.

3. In spite of our vast degree of mechanization, there is seldom, if ever, spare transport.

4. Note that the C.E. has been kept well informed by *G* of future plans and has wasted no time in arranging preliminary reconnaissances.

5. Note the value of R.E. Intelligence. It is quite possible that *E* knew about the track at the coalmine long before the ammunition dump was ever thought about.

6. Dealings with local inhabitants are done through the Mission whenever possible.

7. Concealment from the air should have been considered when the site was originally started.

8. This means the Army Co-op. Squadron, R.A.F., allotted to this Corps. It would be very lucky if it had more than a Squadron. The G.S.O.3 (Air) is part of the G. (I) branch.

9. Camouflage staff are part of the C.E's Branch

10. D.D.O.S. is not concerned with deciding the quantity of ammunition to be held in the dump, but he is concerned about the technical aspect of how it should be stored. He has a technical specialist on his staff, namely, the I.O.O.

11. Notice how the Chief Engineer is acting as Technical adviser.

12. Notice the value of the Chief keeping his subordinates well informed.

13. A Corps probably has one Battalion of Pioneers allotted to it. They are not under command of the C.E. unless this is specially ordered, as quite frequently happens.

14. The Corps Troops R.E. are commanded by the C.R.E Corps Troops. They are not necessarily under command of the C.E., whose primary function is Engineer Adviser to the G.O.C. Often, however, the Corps Troops are put under command of C.E., and many think that this should be a permanent state of affairs.

15. *G* Branch will, of course, know at any given instant the role being played by every Unit (but it would be expecting a lot for the B.G.S. himself to have all the details at his finger-tips).

16. So important a decision should obviously be confirmed in writing. In any case, an order must go out to the Pioneers.

17. *Q* deals with accommodation and no doubt the D.A. & Q.M.G. has an up-to-date map in his office showing the location of each Unit.

18. Under present *War Establishments*, Pioneer Battalions are not self-mobile. If their move is greater than marching distance in the time available, they require an allotment of transport.

19. Notice how the C.C.R.A. obliges for the general good, though he probably dislikes the idea strongly. Notice, too, how the operational aspect is the primary one in his mind.

20. A.D. Survey might attend the Conference, though he would not normally be required to do so. He works in close touch with *G* Branch and, like others, should be kept well in the picture concerning future requirements.

21. Delivery from railhead to dump will be made by the Corps Ammunition Park, which is the third line for ammunition supply.

22. The C.R.E. Corps Troops is not part of the Corps H.Q. but he has to keep in close contact, and whenever possible his H.Q. is sited close to the Corps H.Q.

The Corps Troops R.E. are responsible for R.E. Services in the Corps area, in the same way as Divisional R.E. are responsible in their Divisional area. Notice how the C.R.E. works direct with *Q* in this respect—though, strictly speaking, if the Corps Troops R.E. have been placed under command of C.E., this should not be so. In any case the S.O.R.E. is there representing the C.E.

23. Notice that the decision which Section to send is made by the C.R.E. The C.E. merely said that *a* Section would be wanted.

24. It is wrong for a Senior Officer to do all the detail work. That is what he has subordinates for. In this instance there are the A.Q.M.G., D.A.Q.M.G. and S.C. (Q), any of whom might be dealing with billetting in detail.

25. *A* Branch deals with Personnel. As a guide, any question which can be called a " personal " matter is the concern of " A," for example : Strengths, Discipline, Legal, Postal, Medical, Honours and Awards. (It is interesting to note that though Medical comes under " A," Veterinary comes under " Q." Animals = Movement, a " Q " matter.)

26. The job will probably be done by a Hygiene Section.

27. Reserve M.T. Companies are Army Troops. Each can carry 400 tons or 2,500 men. Corps probably has one such Company sub-allotted to it.

28. A.P.M. is " Chief Policeman," who controls the Provost Company of Military Police (or " Redcaps ").

29. Note the following important people who have played no part or received no mention in this drama :—

	Branch.
G.S.O.2 (Chemical Warfare)	G.
D.A.D.S.	S. & T.
Requisitioning Officer	S. & T.
A.D.O.S. (E)	O.
D.A.D.O.S. Corps Troops	O.
D.A.D.M.S.	Medical.
D.A.D. Postal	A.
Salvage Control Officer	Q.
Camp Commandant	Q.

Plus sundry junior officers, clerks, batmen and a few hundred others !

SOUTHERN BESSARABIA IN 1856.

By the late MAJOR-GENERAL E. RENOUARD JAMES.

[*Note.*—Major-General James (1833–1909) served as a lieutenant in the Crimea and was taken prisoner by the Russians. In 1856 he was a member of the English section of the Commission appointed for the delimitation and demarcation of the new Turko-Russian frontier in Bessarabia, as fixed by the Treaty of Paris. In later years the general compiled from his notes and sketches a *Journal of my Life* which, through the kindness of his daughter, has come into the possession of the Institution of Royal Engineers. The following are some extracts of his experiences on the Commission. The whole account is exceedingly interesting, but it is too long to be reproduced in full.]

THE English Commissioner was Lieut.-Colonel Edward Stanton, R.E., at the time only a young captain in his own corps, but with brevet rank gained for his brilliant service in the late war. Only two Engineer officers were attached to the Commissioner, myself and Charles George Gordon, the future hero of China and Khartoum. We left Balaclava on board the *Kangaroo* transport on the 15th May, 1856. Landing from the *Kangaroo* at Constantinople we spent a few days at Messire's hotel, while the Commissioner received his instructions from the English Ambassador, the famous Elchi, Sir Stratford de Radcliffe. Taking passage by the Austrian-Lloyd steamer *Ferdinando*, Stanton, Gordon and myself embarked for Galatz on the Danube, arriving at that place on the 23rd May.

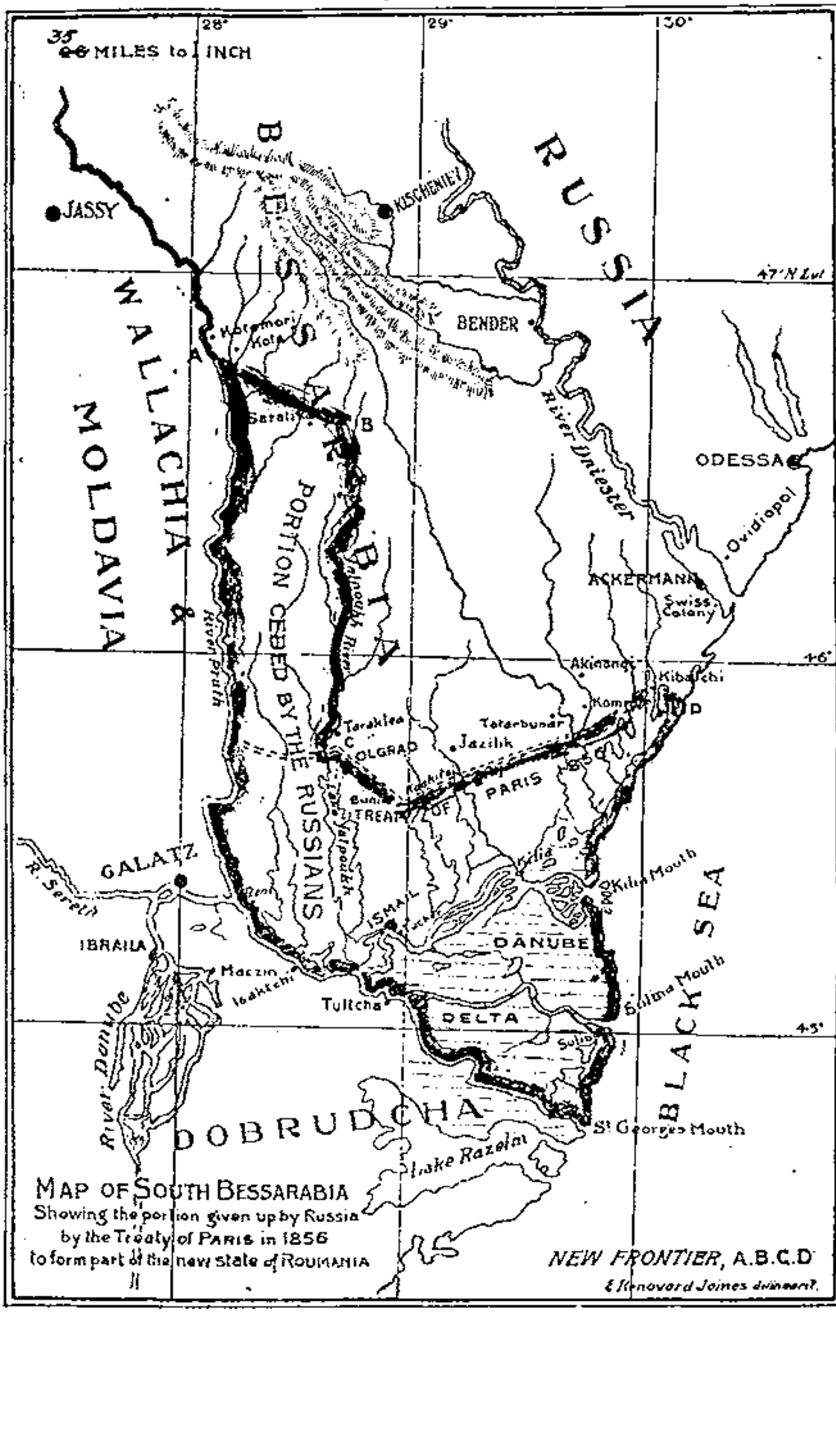
We entered the Danube by the Sulina mouth, which at that time was navigable with difficulty owing to the accumulation of sand on the bar. One of the matters dealt with in the treaty of peace was the improvement of the navigation of the Danube, and a European Commission was appointed for the consideration of means to effect this end. This had not yet assembled but did so not long afterwards; the first British Commissioner being Stokes, R.E. (afterwards Sir John Stokes, K.C.B.), who held the post for about ten years. He was succeeded for a short time by Charles Gordon, and later by Siborne, R.E. Much discussion took place as to which of the three channels of entrance to the river should be selected for improvement, and as various considerations entered into this– political, financial, and engineering in their character—I cannot give space to detail

the reasons which had most weight in fixing the Sulina channel as the one chosen. The plan I give will show that the delta of the Danube is in the form of an irregular equilateral triangle, of which each side is about fifty-five miles long; the northern channel, or Kilia entrance, bounding it to the north; the southern channel, or St. George's, to the south; while the Sulina branch runs centrally through the district, which besides the three main channels is traversed with a network of smaller ones unnavigable for boats of large size. The country is an absolutely flat marsh; a mere swamp, over which reeds are the only growth and wild boars and aquatic birds the only tenants.

Russia had hitherto arrogated to herself a right to river dues and claimed the entrances to the Danube as within the limits of Bessarabia. Some solitary huts—occupied by custom-house guards—were to be seen along the banks of the navigable branches of the river and some miserable hovels at the Sulina entrance afforded shelter to the few officials whose duty it was to collect the dues claimed and tend the small lighthouse. But the intricate navigation of the tortuous channels through the delta was rarely attempted by ships of any size except in daylight; and indeed the preposterous claim of Russia to control the river traffic, with the object, doubtless, of favouring her own export trade from the Dneister, Dnieper and Don, so seriously interfered with the corn exports from the Danube as to have become a grave cause of complaint in the large grain-consuming countries of western Europe. It was, therefore, in the interest of the majority of the powers who were party to the Treaty of Paris to insist on a clause providing for the removal of the cause of complaint against Russia, under which her frontier should be so far set back from the mouths of the Danube as to deprive her of the control of the navigation of the entrances to the river. This was the object of the Commission to which I was attached.

With the windings of the channel our ship the *Ferdinando* had over a hundred miles of river to traverse at a very slow rate; as we went through this desolate fever-haunted swamp we followed such a twisting course that, ever and anon, we seemed to return to the same spot, seeing, over the reeds, close to us some object we had passed half-an-hour before. We noticed wild fowl of every kind in numbers, but not a human being except some lonely Russian frontier guards. It was a melancholy day, and we were delighted when the ship emerged upon the glorious main stream of the river Danube. The current is so rapid that the enormous mass of mud carried along discolours the river; as the stream divides into many branches over the delta the detritus is deposited, forming especially on the bars at the several mouths and causing the channels to shift position constantly.

Between Toultcha and Galatz the country on both banks remains



MAP OF SOUTH BESSARABIA
Showing the portion given up by Russia
by the Treaty of PARIS in 1856
to form part of the new state of ROUMANIA

E Hanovard Joines delineavit.

very flat; but the river, which trends north-westerly at this part, turns directly towards the south from near Galatz and thus, as it flows at this point in a direction roughly parallel to the coast of the Black Sea, the district of low-lying hills known as the Dobrudcha is formed. At the southern base this narrows to about thirty miles from river to sea; and while the river at this point turns to the west again, past Rassova, Silistria and Rustchuk, the isthmus (so to speak) connecting Rassova on the river and Kustendji on the Black Sea is an easily defensible line against an advance from the north. We can see that the peninsula formed by the Dobrudcha constituted in former days a strong bastion against an invasion of Turkey by Russia. It must have been considered so from the earliest times, as we see by the remains of one of the several Roman walls which are to be found in the world, in this instance marked on maps as Trajan's wall, and stretching from Cscernavoda to Kustendji across the neck, which is now occupied by a railway designed to avoid the last two hundred miles of river traffic and at the same time shorten the sea voyage from the mouth of the Danube by one hundred.

The strong natural defence which was afforded formerly by the Dobrudcha peninsula made it usually necessary for Russian advances on Turkey to be made through Wallachia, on the Danube, by some assailable point on the front Rassova-Silistria-Rustchuk; and it will be remembered that the fortresses at the last-named two places checked the advance of the Russian army in 1853–4. The expedition of the allied army to the Crimea, if it had no other result, obliged Russia to abandon the offensive operations against the Danube front of Turkey in order to devote her entire strength to the defensive at Sebastopol. But in the war of 1877 she succeeded in landing an army corps in the Dobrudcha between Toultcha and Isaktchi in support of her attacks by way of that part of the Danube near Silistria; and, as is known, the invading army on the latter occasion reached a point within sight of Constantinople.

We passed within sight of Toultcha, which lies under and on the slope of a hill; for this reason, being so vastly superior a place from the point of view of health than the more important commercial port of Galatz, it was chosen as the headquarters of the Danube Improvement Commission. A little way beyond Toultcha is the opening into the Kilia channel and there the delta ends and the undivided stream of the river is seen for the first time. Northward, the land remains flat and reedy until the embouchure of the Pruth is reached, and in the distance, the salt lakes of Southern Bessarabia, which we were soon to know more of, might be seen. The Pruth is a fine river, which rising in the south of Galicia forms for the greater part of its course the boundary between Bessarabia and Moldavia. Being navigable for ships of small size for about a hundred

miles from its junction with the Danube, the Treaty of Paris decreed that the new frontier line was to be set back to take away from Russia the advantage of this water-way for her gun-boats and small craft.

Our rather tedious voyage to Galatz came to an end at last. On landing we were welcomed by the British consul, who had provided quarters for us. Galatz is a low-lying and most unattractive town; only redeemed by the grand river flowing silently past, with immense timber rafts floating seawards and craft carrying cargoes of grain destined to be reshipped and sent to western Europe. The water is laden with mud, which is probably the reason that the only fishing we heard mentioned was the sturgeon catching, in which a curious method is employed. The fish, not infrequently one hundred pounds in weight, forms an important article in the diet of the lower classes of the riverain population. When returning from the sea its scales are coated with parasites and the fishermen take advantage of the instinct which urges it to rub its itching side against any rough surface it may find in the water, by mooring large faggots in midstream armed with hooks which capture the fish as they swim. We saw this system of fishing in operation.

We made excursions up the river to Ibraila, a grain-exporting port of less importance than Galatz, passing the embouchure of the Sereth, which at this point forms the boundary between Moldavia and Wallachia, a large proportion of the grain grown in the Rumanian province being brought down it to the shipping ports. We were not sorry to leave uninteresting Galatz and to make a start with newly purchased travelling equipages en route to Bolgrad in the south of Bessarabia, which was appointed as the place at which the commissioners were to assemble. The road as far as Reni, the first town after crossing the Pruth, and in Bessarabia, lay along the left bank of the Danube. From there, leaving the river we skirted the salt lakes and arrived at Bolgrad after a drive of about fifty miles. We reached our destination on the 8th June.

The village of Bolgrad, one of the largest in South Bessarabia, lies at the head of the salt inlet Lake Yalpoukh and nearly in the centre of the proposed frontier line. On the morning after our arrival visits were exchanged between Colonel Stanton and the other Commissioners, who had arrived about the same time as ourselves. They represented Russia, Turkey, Rumania, Austria and France. The French Commissioner, Colonel Besson, agreed to mess with us, and as his soldier servant, Francois, was a very good cook, we fared very well in a country where the local cookery was bad and where it was difficult to obtain good meat, bread or butter. The water throughout the south of Bessarabia was brackish, owing to the infiltration of the water from the salt lakes through the porous soil, and yellow in colour. No boiling would remove its salt dis-

agreeable taste and this was traceable even when it was mixed with brandy or in hot tea.

We were given excellent quarters in the houses of the peasantry, both in Bolgrad and in all the villages at which we halted, and were rarely under the necessity of using our tents to sleep in, though we generally erected our marquee to sit in during the day and for our mess. The official treatment of the peasantry in Russia is extremely high-handed. In each village we halted at, the best houses were taken possession of for the members of the Commission and horses were requisitioned for the transport of the personnel and baggage. At Bolgrad the cottages were small and we had a whole one each. As a rule there was one room only, but in some of the better houses two. They were generally whitewashed and scrupulously clean, and in this respect were a great contrast to the foul huts of the *moujiks* I had seen in Little Russia. Three or four very small windows were placed so high that no external view was possible; a broad divan ran completely along one wall for use as a bed, and on the opposite side was a narrow fixed bench; at the end of the room, near the door, was a clay stove for warmth, and there was a shelf just below the ceiling for the household utensils when not in use; tables and chairs were unknown conveniences. Cooking operations were conducted under an external shed, and our horses were under a similar shed or more frequently picketted in the open in camp fashion.

The villages in Bessarabia resembled each other monotonously; there was usually one straight, very wide, unpaved street, along which the houses lay detached one from another; in general, each house was surrounded by an open enclosure. No attempt was made at variety of design or ornament in the buildings and the houses were simply square blocks with a chimney in the middle. But upon the marshy lands the chimneys were very remarkable, as each was the hereditary abode of a pair of storks which returned from year to year in summer and always took possession of the same nest. It was accounted very lucky to have storks on the house; they were never interfered with and their desertion of their nest would be an omen of immanent disaster to the householder. In the villages near the course of the Danube and its tributaries these curious colonies of storks may be seen everywhere, a colony having often in it several hundreds of the birds; and the quaintly sedate movements of the old birds as they sit on the edge of the nest on the chimney, as they feed their young, are most amusing to watch. During the day as many of the birds as can be spared from their domestic duties go off to the marsh where they feed on the little green frogs. On the approach of sunset they all return to their nests, and then the small frogs seeming joyful at the departure of their tyrants commence chattering in concert, making an incessant

WORK AND PLAYS.

By MAJOR R. E. BLACK, R.E.

To attend a large number of lectures in a short space of time is trying to the mind and to the anatomy, but unfortunately there are some subjects which do not lend themselves to instruction by practical work. Nevertheless, ways of breaking the monotony of a series of lectures should be sought, and it will sometimes be found that play-acting serves this purpose excellently. The following suggestions, for which no great originality is claimed, are offered to the many who must now be engaged upon instructing their fellows.

The general idea is to present to the students "A Scene from Military Life" in the form of a play, various lessons being extracted from the drama as it unfolds.

First write your play—since you will be very lucky if you find someone else's exactly suited to your needs. No great talents of authorship are, however, required, and one of the watchwords is "Keep it simple." Some hints to this end follow.

The ideal cast is found outside the class, from any appropriate "Otherwise unemployed," but should none be available, the class itself provides the performers, and a suitable "drill" is as follows.

After allotting parts, let each performer read the script and mark conspicuously the beginning of each of his speeches. Then, by a suitable arrangement of tables and chairs, one end of the classroom becomes the stage, on which the players read their parts while performing suitable actions. Native wit, supported by a few hints beforehand from the instructor, should be sufficient to produce the simple acting required. The first reading is straight through, to "get the hang of it."

The second reading is similarly performed but is interrupted at intervals by the instructor giving a commentary. The purpose of his remarks is to draw the lessons and point those morals which may not be obvious from the text.

The third reading is straight through, but the players are previously warned to pause slightly at those places (marked in the script) where a comment occurred during the second reading. This is so that the audience may have time to "think the comments."

The "drill" given above is obviously not of universal application. The perfect play, for instance, might be so self-evident as to need no commentary. However, even the process described, though it may sound laborious, need not be so in practice.

noise which could be heard in the village half-a-mile away the whole night.

Somewhere in the centre of each village there is an open square on one side of which is the church, and opposite this possibly one or two houses of superior construction to the rest, occupied by the Starosta, or village chief, and Russian officials. At Komrat, one of the largest villages at which we halted, there were houses of a superior type to those usually lived in by the peasantry. The village church with its pear-shaped green domes was a typical example of the Russian style.

Our intercourse with the peasants in Bessarabia who, being a northern branch of the same people as those who inhabit the country to the north of the Balkans and the Dobrudcha, were generally referred to as Bolgars, was most amicable. They seemed a peaceful, orderly and very industrious race. As far as we were able to form a judgment they did not appear to love their rulers. Outwardly they were peace-loving, honest farmers.

In the section of the Treaty of Paris dealing with the Turko-Russian frontiers the plenipotentiaries resolved on the general principle that Russia should be entirely deprived of power to control the navigation of the Danube. This was to be effected by the adoption of a line commencing at a point on the river Pruth near Kotomari, just beyond the limit to which deep water navigation is possible, to follow a direction towards the south-east until it reached the head of the small river Yalpoukh, to descend this river as far as the village of Bolgrad, where it was to turn almost at right-angles and passing clear of the heads of the salt lakes connecting the Kilia branch of the Danube to follow a line to be decided on, until it reached the coast of the Black Sea. It was conceived that the salt lakes, if they were left in Russian hands, would afford a nursery for a fleet of river gun-boats, which could descend at any moment to the Danube. The Russian Commissioner did all in his power to retain some hold on the water communication with the Danube, but the other commissioners, in view of the evident intention of the treaty, disputed the Russian claim. It was decided at length to refer the point at issue to the governments of the several treaty-powers.

We were all fond of sport, and South Bessarabia abounds in game; in the vineyards round Bolgrad there were quantities of quail, on the open ground hares were very numerous, and on the marshes and along the rivers wild geese, ducks and snipe in greater abundance than I ever remember to have found them; on the corn lands we also found great and little bustards, ortolans and other birds which were new to me. The most indefatigable of us was Gordon, who would go out with his gun before the indolent ones of

our party were up, and would return to breakfast laden with hares and wild ducks.

The references to the respective governments resulted in the frontier being definitely thrown back from the village and from the shore of Lake Yalpoukh. The boundary line from this point to the Black Sea was to follow the so-called Trajan's wall, an ancient defensive line, a mere ditch, of no modern value from the side of the Danube, towards which the ground descended in a gradual slope from the Russian side. From the Ottoman side it was absolutely weak as a military position, as was proved in 1877, when the Russian army advanced to the Danube without even the pretence of opposition. They also took the line of the Pruth with equal facility, the Yalpoukh River on the west being no better as a military frontier than the line of Trajan's wall. One cannot conceive how the Paris plenipotentiaries, who it must be supposed were assisted by competent military advisers, could have recommended so absurd a strategic boundary, or thought for a moment that such a frontier line could have the smallest element of permanency. Its life was just twenty years, and it seems hardly worth while to speak of the details of a boundary which only exists as a historical curiosity.

From Bolgrad, James paid a visit to the fortress of Ismail which had been stormed by Souvarov in 1790, and made a pretty sketch of the fortifications which were then being demolished by the Russians in accordance with the treaty of Paris. This sketch with his notes, was deemed worthy to be laid before H.M. the Queen.

We left Bolgrad, he continues, on the 8th July and travelling along the line of Trajan's wall made halts at some five villages, none of which need more than a passing reference. A week's journey brought us to Ackermann, a large place near the mouth of the Dniester. The scenery of South Bessarabia is of a monotonous and uninteresting character. Rising by very gradual slopes from the marshes round the salt lakes, it presents a series of smoothly-rounded surfaces in which similarly shaped depressions, where are the widely separated villages, just relieve the country from being absolutely flat. There are neither trees nor hedgerows, for the few fruit trees in the villages are scarcely worth consideration. On the higher ground are crops of hay and corn, and in the sheltered depressions fields of cucumbers and melons. The *arbuze*, or water melon, is grown in great quantities. It is curious how in a dry soil, when all nature is in a parched condition, the water melon secretes within it a pint of sweet water; with no choice of drink but bitter brackish water to quench our burning thirst, the manner in which our crowd would rush into the melon patches was a sight not to be forgotten.

The crops in the country are exposed to two causes of destruction; prairie fires and locusts. The former arose either by accident or design, a spark might fall by accident on the dried-up pastures in

autumn and flames, which were not extinguished without great difficulty, might be seen advancing with a wide front. The fires intentionally created were with the object of combating a much more serious evil, the devastation of the whole countryside by a swarm of locusts. We had opportunities of seeing fires of both kinds and of forming an idea of the ruin done to the crops by the plague of locusts. It is not always known where the locusts when in flight may have deposited their eggs and this is not detected until a report is received that a regiment of the young brood, with a front possibly of several miles, is on its destroying march. Their march may be arrested, if the direction of the wind is favourable, by lighting the dry grass in front of them and allowing the flames to be driven against their front. At any cost their supply of food must be cut off before the larvæ develop their wings.

I do not doubt that the locusts are much appreciated by the game on the steppes, and this may account for the abundance of prairie fowl in Bessarabia. We shot great and little bustards, floricans, ortolans, partridges and quails. A great bustard is a fine trophy for a sportsman as, not to mention that he is as big as a turkey and very good to eat, no little skill is necessary to get one. He is such a wary bird that the peasants did not attempt to approach him on foot, but concealed themselves in their country carts, which the bustards were not believed to fear so much as human beings.

We arrived at Ackermann on the 13th July and stayed some time there. It is a large place, on the southern shore of the inlet of the sea at the mouth of the Dniester. We were given excellent quarters and pitched our large marquee in a garden overlooking the water, using it as a cool place to pass the day, for the weather had become very hot. From Ackermann, Stanton, Gordon and myself made a three days' excursion to Odessa, a distance of about thirty miles, including the passage across the mouth of the Dniester, and we put up at a fairly good hotel. The shops were full of relics made from the timber of *H.M.S. Tiger*, a ship wrecked on the coast near during the war.

We enjoyed the rest of our stay at Ackermann, for our house being near the shore of the estuary the summer temperature was modified by a cool sea breeze. We bathed in salt water daily and had some pleasant rides in the neighbourhood. Among other places we went to I remember a colony of Swiss-Germans who had been encouraged to settle in order to improve the grape culture, and they made some very nice wine of the hock type.

The Commission left Ackermann about the middle of August and retraced its steps along the entire length of the new frontier. I remember the names of some of the places we stayed at, Tatarbounar, Komrat, Taraklea and Bolgrad again for some days, various small villages along the course of the river Yalpoukh, and finally Kotomori on the bank of the Pruth, where the frontier ended. From the last

place, having completed our field work, we went to Kischenief for the winter to prepare the plans and records. We reached that place on the 8th October, having completed the surveying operations in rather less than two months from the time we left Ackermann. We found the Russian map of the country so accurate that the insertion of the frontier line on it was an easy matter, and after we left Bolgrad, and the line followed the course of the Yalpoukh, the verification of the map was simple enough, the only thing to be done by us being to agree on the position of the " thalweg ", or centre of the main channel, which had been decided on as the exact boundary to be adopted.

While we marched up the Yalpoukh valley we found plenty of time for sport among the wild fowl, which were in the greatest abundance and in every variety. As we approached the head of the valley the country changed in character, from steppe to forest and from plain to hill, and became more picturesque. We did not linger long in this country, and in our carriages, a short day's journey across hill and valley through woods took us to Kischenief.

Kischenief, the capital of Bessarabia, is a town offering very few attractions, either in the beauty of its site or in its buildings. Laid out with the usual rectangles, the straight streets being twice as wide as is necessary for convenience, the houses, except on a small area in the heart of the place, are one-storied and detached. The streets are unpaved, and when they are not seas of liquid mud, are inches deep in dust. In mid-winter only, when they are covered with hard snow, are they at all pleasant to travel on.

Our time was fully employed in the work of the Commission. The plans to be drawn were about thirty-five in number, large and small, and Gordon and I between us made them in triplicate, so that in fact we drew more than a hundred in six months. I remember a curious circumstance which proved that Gordon was colour-blind. We were astonished one day to see him colouring a plan vermillion, which he maintained obstinately was green.

We had long rides in the country round Kischenief, which was more picturesque than southern Bessarabia. The scenery, though in no wise remarkable, had the charm of alternate hill and valley with much woodland. One of our longest excursions on horse-back was to Bender, a distance of 35 miles. This place is famous as the asylum of Charles XII of Sweden after his defeat at Poltawa in 1709. We also, on the invitation of the general-in-chief, attended some Austrian manœuvres at Jassy in Wallachia.

The labours of the boundary commission came to an end in March, and Gordon and myself travelled to Galatz to embark for Constantinople, where we were ordered to join the Commissioner for the delimitation of the Turco-Russian frontier in Asia Minor.

THE ENGLISH AT THE SIEGE OF ROUEN IN 1591-2.

By COLONEL F. E. G. SKEY.

IT is not pretended that this is an exhaustive history of the campaign of Essex and his four thousand on behalf of Henry of Navarre. It consists mainly of extracts from an old book which I picked up in a second-hand bookshop, and which when I came upon them struck me would be of interest to readers of *The R. E. Journal*. The book is called *History of the Civil Wars in France*, and is a translation of the Italian work by H. C. Davila, who himself was present at some of the incidents that he records. It was published "at the Savoy" and printed "by T. N. for Henry Herringman, at the Blew Anchor, in the Lower Walk of the New Exchange," and dated, second impression, 1678.

It is common history that in the winter of 1590-1 Henry sent Turenne to Elizabeth to beg the aid of English troops in his struggle with the League. The bait was the promise of a French port on the Channel to replace the lost Calais. Rouen may have been mentioned or Havre-de-Grace, the two last remaining strongholds of the League in Normandy. At any rate about this time Henry decided to besiege Rouen, "partly because of the promises wherewith he had engaged himself to the Queen of England, either to give her some jurisdiction in that city, or to assign her some other place upon the Sea side." Essex, who was in correspondence with the King, implored Elizabeth to give him command of the expedition and after much indecision she reluctantly granted him the commission on the 21st July, 1591. Whether he landed at Boulogne, as Davila records, or at Dieppe, or whether his force was 3,000 strong or 4,000, matters little, but he joined the force of some 12,000 men which Henry had detached from Noyon under Biron to advance on Rouen and make preparations for the siege.

There is no mention in this history of Essex's adventurous ride through the enemy's country to interview the King, or of the festivities that occupied the three days of that interview, or of Essex's hawking adventures, and Essex is not credited with the capture of Gournay, the credit for which is given to Biron. Davila's dates too are not very reliable, for he gives a date in November for the skirmish in which Walter Devereux was killed, which occurred on the 8th September. Here is his account of the incident :—

"...first the Cavalry and then the Regiment of English, skirmished

fiercely for many hours, though at last being weary on both sides, they retired willingly without advantage; the besieged vaunting of a happy beginning, by reason of the death of a Nephew (brother) of the Earl of Essex, who, his courage having drawn him into a most dangerous place of the fight, was slain by Borosey with a pistol-shot in the throat." Davila goes on to record how the besiegers attempted to arrange the capture of the Porte de Beauvais by treachery and how the attempt failed. "But the next day the Chevalier Piccard sallying out from St. Catherine's to skirmish and the Earl of Essex with the English coming out of the wood of Turinge, they contended with words no less than deeds: for Piccard upbraided the English, that not having courage enough to revenge the death of the Earl's Nephew, they sought to advance their designs by treachery, they came to ill language, and to give the Lye, for which, as soon as the skirmish was ended, there came an English Trumpet from the Earl of Essex, to challenge the Governor; which the Chevalier Piccard (who had spoke the words) having answered, it came not to a duel; for the Earl refused to fight with any other than the Governor; and the Governor, though he refused him not, yet he referr'd the Duel till another time, when he should be free of the charge of that present defence, to which, as a publick cause, he was both first and more deeply engaged."

The Governor was the Sieur de Villars, a brilliant and resourceful commander, whose conduct of this defence is one of the most active in history. "He called all the Heads of the Clergy, the principal men of the Parliament, the chief of the People, and the Officers of the Souldiery, and distributed to everyone his part of those labours that were to be undergon in their future defence." In distributing the tasks he gave to the Chevalier Piccard the defence of St. Catherine's Mount, "wherein the sum of the business consisted." The attack on this important section of the line fell to Essex and his men.

On the 3rd December the King arrived and completed the investment and on the following day "they broke ground to make their approaches to the Wall." "The King lay at Darnetal. ....The English foot lay on the left hand of the King... against the Porte St. Hillaire, and the Mount St. Catherine.... "The King began to cause two Trenches to be cast up, one to approach St. Catherines Mount, which (being drawn from the Wood of Turinge) was wrought at by the English..... But the Sieur de Villars... had before the Forts of St. Catherine (where the utmost force of the seige was applied) drawn a Brestwork of eighteen or twenty foot thick, flanked with two Ravelines onely for the use of Muskettiers, having neither Shoulders, Orillons, nor Retreats; and before this a Moat of thirty foot wide, and ten foot deep;

which was a very fit obstacle to hinder, and keep at play the first fury of the assailants." "....The two trenches were scarcely begun, when five Companies of Foot, seconded by Boresey with 120 Horse, sallied out of the Porte Cauchoise ; and on the other side Three hundred Provincials armed with Corslets and Halberds or Partisans, flanked by a hundred French Firelocks, came down from St. Catherines, and with infinite violence assaulted those that were making the Redouts. On the one side the English ran to oppose this Sally... and the fight grew so hot on both sides, that it lasted above three hours with great execution, till the Baron de Biron being came up with a Body of Four thousand Germans and two great Troops of Horse, sent back those of the Town, whereof there were slain above forty ; but on the Kings party above Two hundred.

"The Pioneers were terrified with this assault, to which the crossness of the weather being added (which first with excessive Rains, then with very deep Snow and hard Frosts, hindered all manner of working) the approaches went on but slowly.... At last the approaches that were making at St. Catherines were brought to perfection, though they proved very streight, and had only three Redouts ; but they were favoured on the right hand by a long battery of fourteen pieces of Cannon, and on the left by seven more ; but planted so far *off*, that the Commissaries that had them in charge, did not care to fill their Gabions ; yet under favour of their shot, the works were advanced so forward, that they were brought to the Counterscarp of the Fortification that was newly made, which being something high, and the Trench of the besiegers very streight at that end (all defects of the English Engineer) a great number of men were slain by the incessant storm of Musket-shot, which was poured from those that were behind the Parapet of the same Counterscarp : Wherefore it being necessary to beat them away, and that not being to be done by day .... the King coming personally into the Trench with three hundred Gentlemen, accompanied by four hundred gallant Firelocks, gave a fierce assault to that place in the greatest darkness of the night, which it not being possible for the defendants to sustain, they quitted the Counterscarp, and (as Soldiers say) filing off to right and left hand, under favour of the Fortifications, they retired into the Moat. Sir Roger Williams, a valient Colonel, entered presently with Eight hundred English, and Gabions being brought with wonderful speed, he covered himself, working all night upon the edge of the very Moat ; but the night following, the Sieur de Villars . . . valiently regained the Post, beating the English from thence, who being hailed upon with a thick shower of Musket-bullets, durst not stand up to handle their Pikes ; but being terribly vext at the affront they had received, prepared themselves the two dayes

following, and on the third at night, assaulted the Counterscarp so precipitately in the King's presence, that the Defendants being driven out, they lodged themselves there, and with infinite speed and diligence fortified and covered themselves more than sufficiently.

" The end of the Trench was thrown open into the Moat upon the 29th of December, and upon New-years Eve two Batteries were raised. These, though they thundered all the day, and continued all the night following . . . yet did they make but little progress, the Forts being all of good earth, and newly turfed, and the Artillery being lower than the Forts, battered more weakly, and made much less impression. Wherefore, upon the second day of the year 1592, they began to make a platform in the midst between the two Batteries, that they might play more strongly against the Forts. The besieged would not pass that night in idleness, but coming down between the Hill and the City, assaulted the Trenches . . . and having put the Guards in confusion, killed above Sixty of them, carried away many of their materials (or digging tools) and would have thrown down all their Work, if Sir Roger Williams making opposition himself, with a few to second him at the Gorge of the first Redout, had not long sustained the violence of the Enemy; for laying hold of a Pike, and with him two Captains, an Ensign, and a Serjeant doing the same, he so bravely stood the fury of the Assailants, that a few other Soldiers working a little behind, made a gap in the Redout, and fresh men still coming up, who at the noise of the fight ran to assist their fellows, the heat of the assault was first sustained and then other Squadrons of the Army coming one after the other, they of the City were at last forced to give over the enterprise, and retreat, though with much gallantry and reputation: nor did the fight end because they were retired; for with their Artillery, Harquebuzes a Croc, throwing Fire-works, and a thousand other wayes, they ceased not to molest and hinder the progress of the Battery."

During January the defenders made some important sorties, and in the course of that and other fighting many of their best leaders were killed. As a result of this " they slackened their sallies, and therefore the approaches of the Army still advancing, the assailants were in many places fortified upon the Counterscarps, and at the old Fort of St. Catherine . . . having also passed the Moat, they were working Mines under the Walls. . . . The soldiers laboured with so much ardor that by the sap they brought themselves under the Bulwark of the old Fort; and having reduced it all upon props, the Commanders believed that without Powder it would all fall of it self, as soon as the props should fail; wherefore, having drawn up two Squadrons in a readiness to go on to the assault, the props were set on fire; but the Earth, which was admirably good, and well beaten, sunk down so gently, that without opening it self, or

falling to pieces, it onely sunk down upon the ground, the Bulwark remaining lower, but not broken, nor discomposed on any side, which was the cause, that without any further attempt the Foot returned all into their Trenches. They then began to make a Mine in the same place, to do that effect which could not be done with the Props. . . . "The Mine at the old Fort was already perfected, and was to be sprung the next morning, when Colonel Boniface going the round to visit his Guards in the still silence of midnight, heard the noise of the working in that place, and having caused many Fireworks to be cast into the Moat, to discover what the Enemy did; those fires running up and down, and scattering themselves into many places, by chance found the mouth of the Mine, and gave fire to it before the time, in such manner, that the blast striking backward, and carrying part of the Bulwark with it, burned and overwhelmed with Earth all the out-guard, and hurt many of those that were preparing themselves against morning, to give the assault; yet the ruine was so large, and the Earth so overturned at the point of the Bulwark, that it might easily have been assaulted, if that sudden accident, and the death of the chiefest of them had not terrified the assailants; so that the Baron de Biron, who was to give the sign for the assault, not being in the Trench, and the Foot that were to make it not being drawn up in readiness, the Earl of Essex and Sir Roger Williams standing firm upon their guards, sent away in haste to receive Orders what to do, and in the mean time the Defendants with sacks full of Earth and brush Faggots, repaired the breach in short space."

Meanwhile the Duke of Parma with a large Spanish Army, had entered France for the relief of Rouen, and King Henry when he marched away to manœuvre against the advancing enemy, left only a weak infantry force to support the besiegers. Parma by skilful manœuvring avoided the King and on the 26th February intended to attack the covering force. "But, upon the twenty-fifth day, the diligence and valour of the Sieur de Villars had already prevented his design: for, he seeing the King was absent with all his Horse, and that the Foot of the Camp was divided at many several Posts, and not being willing to suffer another to have the glory of raising the siege, if he could do it by himself, he determined to try if by a bold sally he could put the enemies affairs in disorder: and being advertised by an Irish man who was run away from the Camp, that since the departure of the King with the principal Lords, the Guards were not so diligently kept . . . he set himself in order to sally in four several places, and assault all the Posts at once. . . . "All these things were in order at break of day, and the sign being given by Cannon-shot, they sallied with singular gallantry, and with so much violence, that the passage to the Trenches being taken both before and behind, and the Guards surrounded, they made a

wonderful great slaughter in every place, took the Cannon, some of which they nailed, some they threw into the Moat; they spoiled the engines and instruments of War in all places, gave vent to the Mines, blew up the Ammunition, and filled every place with death and terrour; so that all the Foot making no further resistance, fled without stop toward Darnetal.

"The Alarm had been suddenly given, and the Marechal de Byron with four thousand Swissers and Germans, and with those Gentlemen that were remaining in the Camp, was coming at a great pace to succour the Trenches; but Captain Perdriel, who sallied after the Governour at the Porte de Beauvais with three Troops of Horse, over-ran the Plain, and wheeling and skirmishing briskly, endeavoured to keep him in play . . . till the souldiers had done what they intended in the Trenches; which having fully performed, all those four squadrons likewise advanced to receive the encounter of the Marechal de Byron, and between the Trenches and Darnetal they made a bloody fight . . . yet the other Squadrons and the Germans coming up, and the English and French Infantry rallying themselves together on all sides, they of the Town were beaten back, though with much ado, and driven to their very gates.

"But the Ammunition being blown up, the Artillery taken, and all things put in confusion, the loss was inestimable and irreparable for a long time. There were slain on the Kings side above eight hundred Souldiers in the Trenches, and amongst them two French Colonels, and fourteen Captains of several Nations."

The siege was over, and the English never set foot in the Fort of St. Catherine's. Essex had been finally recalled before the final disaster and Sir Roger Williams remained in command of the English contingent. But it is not proposed to pursue their fortunes, or rather misfortunes, further.

I must now admit a secondary reason for reproducing these old extracts. It is this:—When I came upon the account of the destruction of the English mine I was reminded of the lines in Hamlet:—

> "For 'tis the sport to have the enginer
> Hoist with his own petar, and't shall go hard
> But I will delve one yard below their mines,
> And blow them at the moon: O, 'tis most sweet
> When in one line two crafts directly meet."

And, if this, may not other passages in Hamlet refer to this expedition? In Act 4, Scene 4, one seems to see other references:—

> "Witness this army of such mass and charge,
> Led by a delicate and tender prince,
> . . . . . .
> greatly to find quarrel in a straw
> When honour's at the stake."

And earlier in the scene :—

> " We go to gain a little patch of ground
> That hath in it no profit but the name."

and the lines following.

It seems to me as fair to apply these lines to Essex at the Siege of Rouen and to the Fort of St. Catherine, in 1592, as with Professor Dover Wilson, to the sand-dunes of Ostend in 1602.

AIR SURVEY.

By MAJOR D. R. CRONE, R.E.

(Survey of India Pamphlet. Second Edition, 1939. Price 1 rupee.)

This pamphlet forms Chapter XII of the *Survey of India Handbook of Topography*. It is a small book of less than 100 pages, but it gives an adequate account of the methods in use by the Survey of India in the important task of converting air photographs into maps.

In the Preface to this Second Edition the Surveyor-General of India, Brigadier (now Sir Clinton G.) Lewis, remarks that " one of the main tasks of photogram- " metry with which India is especially concerned . . . is the mapping of large areas " of unadministered tribal territory which are inaccessible on the ground. The " development of precise methods . . . is very largely due to original research " carried out by Major D. R. Crone."

The pamphlet deals only with graphical methods of constructing maps from air photographs, and intentionally omits from consideration the use of elaborate plotting machines, such as have been so much employed on the Continent of Europe. In the use of these graphical methods the chief difficulty is the drawing of the contours, a matter of prime importance in the survey of a sparsely-populated hill-region, where, we may almost say, there is little else to show.

Major Crone explains that the use of oblique air photographs is chiefly to provide the dense height control necessary for contouring the vertical photographs. For taking these oblique photographs the camera is fixed at a constant angle, so as to include the horizon in the field of view.

The various steps in the complicated process are described in a practical manner. But, from the nature of the case, the handbook is designed rather to be a guide to the Survey of India expert than to instruct the intelligent layman. In fact, without the photographs and apparatus in front of him, the latter will find some of the instructions difficult to follow. And, in any case, the system requires an amount of study and attention to master which no one is likely to spend upon it, unless he is obliged to undertake similar work himself. But we may, nevertheless, congratulate Major Crone on having evolved a practicable method of the graphical contouring of country inaccessible on the ground.

MEMOIRS.

LIEUT.-GENERAL SIR AYLMER G. HUNTER-WESTON, K.C.B., D.S.O.

COLONEL COMMANDANT ROYAL ENGINEERS.

LIEUT.-GENERAL SIR AYLMER GOULD HUNTER-WESTON, who died as the result of an accident at his home, Hunterston, West Kilbride, on March 18th, 1940, at the age of 75, was a conspicuous and well-known figure during his career. An outstanding personality, an enthusiastic and optimistic soldier, an inspiring leader of men, he brought everywhere he went an atmosphere of his own abilities, restless activity and determination.

Born in 1864, a son of the twenty-sixth Laird of Hunterston, Ayrshire, he passed through Wellington College and Woolwich into the Royal Engineers in 1884. He afterwards passed through the Staff College in 1898–99.

The following is a brief précis of his various services and commands. He was actively employed in the Miranzai Expedition in 1891, in Waziristan, 1894, in the Dongola Expedition in 1896, in the South African War 1900–02, and in the 1914–18 war, first in France, then at Gallipoli and again in France.

He first came into prominent notice in the South African War, by feats of courageous and striking enterprise, when his bravery, technical knowledge and coolness in emergency made him a marked man and noted for further advancement. The following is an account of two of these performances made by an officer who served with him in the newly formed Field Troop, Royal Engineers, attached to the Cavalry Brigade.

The outstanding performances of the Field Troop during the first six or seven months of 1900 were three raids, which were carried out by small bodies of mounted sappers under the personal leadership of Hunter-Weston, with the object of cutting railway communications behind the Boer front line. Two of these were successful, while the third, though gallantly executed, failed in its main purpose.

The first of these raids had for its object the cutting of the railway line north of Bloemfontein. Hunter-Weston led a party of about ten sappers and a couple of local scouts round the east side of the town, penetrating the enemies' outposts, and destroyed a culvert

Lt Gen Sir Aylmer Hunter-Weston KCB DSO DL JP_KCB DSO DL JP

a mile or so north of the town. The effect of this demolition was to bottle up an appreciable amount of rolling stock in and south of Bloemfontein and further to prevent reinforcements arriving from the north, including, it was believed at the time, the Commander-in-Chief of the Boer Army.

This operation involved a night march of ten to fifteen miles through unreconnoitred country intersected by dongas. On its return journey this small party ran straight into a Boer picket that rode away without opening fire on being challenged. Hunter-Weston displayed great coolness, and his confidence imparted itself to the men, who behaved splendidly.

The other occasion was a couple of months later, when Hunter-Weston was ordered to cut the railway north of Kronstadt. The main body of the Cavalry Division, to which his Field Troop was attached, was some miles south of the town, and about ten sappers were taken and an escort of one squadron of cavalry. It soon became apparent that it would be impossible for a body of this size to escape the attention of the Boer outposts, so the Cavalry were sent back soon after dark and the sappers went on alone. They were accompanied by Burnham, a well-known and experienced scout. The party marched through the night and two or three hours before dawn it was decided to make the attempt on the railway.

The railway line was located with some difficulty, and matters were not made easier by the fact that a long column of retreating Boers were marching northwards on a road alongside and parallel to the railway. Hunter-Weston and Burnham, however, managed to dodge through this column, taking with them Corporal F. H. Kirby (now V.C. and a retired Group Captain of the R.A.F.) and the explosive charges. They laid the charges, lit the fuzes and made their way back to the rest of the party. On their way back to rejoin the main body, three prisoners were taken and again they ran into a Boer picket with whom they exchanged shots, but no one was hurt.

There is little doubt that these achievements of the Field Troop in the South African War led to the formation of several other field troops after the war, and that a Field Squadron came to be recognized as an integral part of a Cavalry Division.

His career during the remainder of this war was more normal. After holding several Staff appointments he became Chief Staff Officer to General French and subsequently commanded with success various columns.

A brevet Lieut.-Colonelcy, a D.S.O. and a number of " mentions " brought him home in 1902 marked out for further advancement in his profession.

He then held several General Staff appointments in the Eastern and Scottish Commands, and at the War Office as Assistant Director of Military Training.

The outbreak of war in 1914 found him in command of the 11th Infantry Brigade at Colchester and he went with it to France with the British Expeditionary Force. His handling of his brigade in the early days of the war at Le Cateau, in the subsequent retreat, at the battle of the Marne, and at the crossing of the Aisne at Venizel Bridge procured him promotion to Major-General for " distinguished service in the field."

The following is extracted from the official account of the action of the 11th Infantry Brigade in crossing the River Aisne at Venizel Bridge on the night of 12th–13th September, 1914.

" At 7 p.m. on the 12th September, after marching all day in heavy rain, the 11th Infantry Brigade received orders that it was to push on from Septmonts and if possible seize the crossing over the River Aisne. Three officers were sent forward with a local guide to reconnoitre. At 11 p.m. the Brigade started to advance, which had to be conducted by the Commander (Aylmer Hunter-Weston) by the map, the Reconnoitring Officer who returned to guide the column being completely exhausted.

It was reported on arrival at the bridge that one of the four big charges placed to destroy the bridge had failed to explode and that, though the main girders on both sides of the bridge were cut, the reinforced concrete of the roadway was holding the bridge sufficiently to enable the roadway to be used.

After the roadway had been tested by the Commander personally, the Infantry were passed across the centre of the bridge carefully, in single file at two paces interval, covered by an advanced party of the Hampshire Regiment. The ammunition carts were unloaded, and they and their contents passed over by hand. It was not till 3 a.m. on the 13th that the brigade had passed over and assembled on the other (north) side.

To hold the crossing, the Commander decided it was necessary to hold the heights above (Bucy le Long) which dominated the bridge. He therefore ordered the brigade to advance and occupy these heights at the point of the bayonet, no firing to be allowed. Thanks to the boldness of this movement it was completely successful, the heights were seized and entrenched without opposition, the enemy making no attempt to hold the trenches they had made overlooking the bridge.

The Germans were completely surprised and those that were met retired immediately on the main body.

In addition to the heavy work of crossing the bridge and scaling and entrenching the heights, with no rest and very little food, the actual distance covered in pouring rain and through thick mud by the 11th Infantry Brigade under its Commander, Aylmer Hunter-Weston, this day and night exceeded 30 miles."

He was then selected to command the 29th Division, which he

took to Gallipoli and which he handled well at the landing at Cape Helles and in the confused and costly fighting on the Gallipoli peninsula. His courage and invincible optimism were never seen to greater advantage than in these operations and his promotion to the temporary rank of Lieut.-General, with the command of the VIII Corps, was thoroughly well deserved.

Invalided home for a time, he returned to the command of the VIII Corps in France, which he retained until the end of the war, being promoted to the rank of Lieut.-General for "distinguished service in the field."

He retired from the army in 1920 and was appointed Colonel Commandant of the Royal Engineers in 1921.

Besides the brevet promotions to Major in 1895—to Lieut.-Colonel in 1900—and to Colonel in 1908—he received the distinction of D.S.O. in 1902, was awarded the K.C.B. in 1915 for his service in Gallipoli and was mentioned many times in Despatches. He was also made a Commander of the Legion of Honour, a Grand Officer of the Belgian Crown, besides receiving both the French and Belgian Croix de Guerre. On coming of age, he became a Knight of the Order of St. John of Jerusalem and rose to high honour in that Order.

He married in 1905, Grace, the only daughter of the late Mr. William Strang Steel, of Philiphaugh, Selkirk. It was an ideal and most happy marriage, and there were very few periods during his 35 years of married life when Lady Hunter-Weston was not constantly at his side, a devoted comrade and helpmate.

Although retired from the army, his after life was by no means a retired one. Besides the time and attention given to his duties in the House of Commons, and the care and management of his estate at Hunterston, he took his position as Colonel Commandant Royal Engineers, very seriously. He had a great hold over the R.E. Old Comrades' Association and made a point of attending every Veterans' Re-Union he could reach. His presence was very much appreciated by all ranks, and his speeches were quite the event of the meetings, at which he was President for many years. He also presided at the Annual Corps Dinner.

His greatest effort as Colonel Commandant was a tour that he and Lady Hunter-Weston made through India in 1936-37. They visited practically every station in India and Burma where there were Royal Engineers, or their Indian equivalent. He also paid a visit to Waziristan, where he had fought and been wounded in 1894, and made acquaintance with several old natives who had then fought against him.

There is no doubt that this tour did much good in encouraging officers and men to join the R.E. Old Comrades' Association. On his return to England he was entertained at dinner by his fellow Colonels Commandant to show their appreciation of the great efforts

The 'Horn of the Hunter'

he had made on behalf of the Corps during his tour in India. His tour was described by General Duperier as extending from Waziristan to Cape Cormorin and from Bombay to Burma.

Again in 1938, Hunter-Weston and his wife made a long cruise in the West Indies, visiting Jamaica and also Bermuda. At these places they visited and entertained all the various Royal Engineer detachments who were quartered there.

In 1938 he and Lady Hunter-Weston entertained at Hunterston the members of the Royal Engineers Old Comrades' Association in Scotland at a garden party. Royal Engineers, both serving and ex-service of all ranks and all ages with their wives and families, came from all parts of Scotland; over 500 were present and the *esprit de corps* was fully manifest.

It was in 1916 that he decided to stand for Parliament, and was elected to the House of Commons, during his absence in France, for North Ayrshire, and afterwards in 1918 for the combined constituency of North Ayrshire and Buteshire, as a Unionist.

His maiden speech in the House of Commons, on man power, attracted considerable attention, but though he continued to sit in Parliament till 1935, he only occasionally took part in the proceedings of the House.

But as a member of Parliament he rendered service of inestimable value to his constituency in local affairs, and to his constituents in giving assistance in matters which affected their every-day life and personal welfare. That aspect of his life as their Parliamentary representative he regarded as a sacred duty, which he discharged with the determination and energy which characterized his whole career.

Although never stressing the party side of politics, he fought his election campaigns with outspoken vigour and courage, standing up for the principles he believed in. His good humour, which never deserted him, and his eagerness to serve everybody, gained him the affectionate regard of all his constituents, irrespective of party or belief.

"Hunter-Bunter" was the nickname affectionately bestowed on him by the army, and it followed him into his after life, and though he joked about it, he appreciated its significance as a compliment.

He was always ready to help any good cause in North Ayrshire, Arran and Bute.

After he retired from politics in 1935, he, as Laird of Hunterston, continued all his keen interests in local affairs. He was actively interested in, and associated with, the British Legion, West Kilbride Branch, and took deep interest in Toc H, the Boys Brigade and the Boy Scouts, of which he was a Commissioner.

He was a Knight of Justice and Chancellor of the Order of St. John of Jerusalem and was made Bailiff Grand Cross in it, for long

and distinguished service: his wife, Lady Hunter-Weston is a Lady of Justice of the Order.

In Freemasonry he was R.W.M. of Mother Kilwinning Lodge No. 0, and Past Provincial Grand Master of Ayrshire. He was a J.P. and Deputy Lieutenant for the County of Ayr.

At Hunterston, in 1936, on his retirement from political life, he and Lady Hunter-Weston were presented at a large gathering with an illuminated address containing nearly 10,000 signatures.

Towards the end of his life, in 1940, he joined the Agricultural Executive Committee in Ayrshire. One of his last appearances in public life was at Ayr in the beginning of March, 1940, when he gave a heartening send-off to the County of Ayr General Construction Company of the Royal Engineers, shaking hands with each man, speaking to each as a brother sapper, while presenting to each a pamphlet full of wise instructions that he had prepared.

Such is the concise record of a very well-known officer of our Corps. There are many more interesting details that might be filled in, but at the present time it is very difficult to collect them.

From his very first joining the army at the School of Military Engineering, he became noted among his brother officers for his prominent activities and his ambitious plans. His striking and distinguished appearance made him easily recognizable, and gained for him the nickname of "The Count." This was afterwards superseded by the more widely-known and descriptive one of "Hunter-Bunter," and by this he was well known, not only throughout the army, but also by a wide circle of his many friends in civil life, until the end of his life.

Many stories have been told of his sayings and doings—some amusing, some ludicrous and some pathetic, but in none of them can be found any trace of animosity or ill-feeling. Many others have been put down erroneously to him, accompanied by some such remark as "Dear old Hunter-Bunter, how like him!"

Those of us who knew him as a brother officer and comrade during his long army service and afterwards, will always fondly remember him for his generous nature, his outstanding personality, and his unfailing and affectionate friendship.

L.B.F.

Maj-Gen Henry Willaim Duperier

MAJOR-GENERAL H. W. DUPERIER,
COLONEL COMMANDANT R.E.

MAJOR-GENERAL HENRY WILLIAM DUPERIER was the son of Major Charles Duperier, of the 80th Regiment, and was born at Chatham on 9th September, 1851. He was educated at Plymouth, and joined the Royal Military Academy, Woolwich, in July, 1868, being one of the youngest Cadets of his batch. He was commissioned in the Royal Engineers on 4th January, 1871.

After completing the two years' usual training at the School of Military Engineering, Chatham, he was ordered to Devonport. Having volunteered for Indian service, he was posted to the Indian Establishment on 15th August, 1873. His first introduction to India had been when, as a baby, he had accompanied his parents there, returning however a year or two later. He landed at Bombay on 4th December, 1874, with a draft of R.E. which he had commanded on the voyage out in H.M. Troopship *Crocodile*, and arrived at Roorkee on Christmas Eve, it having taken twenty days to reach with the draft the Headquarters of the Bengal Sappers and Miners.

Almost immediately after arrival at Roorkee, Lieut. Duperier applied for the P.W.D., to which he was appointed about three months later, having in the meanwhile been transferred to a company at Peshawar. Part of the journey from Lahore was accomplished by *dâk gharri*, the railway having then not been completed beyond Jhelum. The work at Peshawar was interesting, as the company was engaged, a few miles out of cantonments, in excavating a Buddhist mound in search of coins, pottery, and sculptures. He soon, however, received orders to join the irrigation department on the Ganges Canal at Bulandshahr, near Meerut. Here he served under Major Philip Marinden, R.E., and temporarily rejoined the Bengal Sappers to take part in the assembly of troops at Delhi for the visit of the late King Edward VII, when Prince of Wales.

In 1875 orders came for a transfer to the Cawnpore Division of the Canal, where Captain J. G. Hall, R.E., was in charge. It was whilst employed here that he narrowly escaped drowning. The then Executive Engineer, the late Colonel C. W. I. Harrison, Royal Bengal Engineers, was anxious, in order to compile some statistics, to reach a point 40 miles up the canal by night, so as to measure the discharge of water in the channel early next morning. Accordingly he, Lieut. Duperier, a native clerk and some native boatmen were being towed in a row-boat, when by some misadventure the boat was capsized and all were thrown into the water. It was 10 p.m. on a pitch-dark night, the canal was eight or ten feet deep and the stream was running at about four miles an hour. Lieut.

Duperier was a poor swimmer and was hampered by being in flannels and heavy boots; the opposite bank was about 90 feet away. When he thought he was done for, his hand grasped what proved to be an overhanging branch of a tree on the far bank and he struggled ashore. On rejoining the party, crossing back by a bridge nearby, he found that two men, the native clerk and an orderly who was an expert swimmer, were missing; their bodies were found some miles downstream a few days later.

After four years in the very hot district of Cawnpore, he was transferred to the Western Jumna Canal at Saharanpur, under Major V. Corbett, R.E. Soon after arrival here the Afghan War of 1878-9 claimed Lieut. Duperier's services in the Kurram Valley, where he served a year, engaged in constructing posts of defence, roads and the various works which constitute the duties of Engineers on Field Service. On the termination of this campaign he was transferred to the Military Works Department and was ordered to report for duty in the office of the Defence Committee at Simla, which was then under the orders of Colonel A. M. Lang, R.E. It was here that he met Ethel Lang, to whom he was married on 1st September, 1881, at Kasauli, to which military station he had been transferred on promotion to Executive Engineer.

Furlough to England was necessitated in 1882 by a threatened attack of abscess on the liver. On return to India, Captain Duperier was posted as Executive Engineer, Military Works, Meerut, which included the stations of Delhi, Muttra, Chakrata, Dehra Dun, Roorkee and Landour, as well as a few rest camps and remount depots. After four years a change of scene was brought about by transfer to Quetta, where considerable expenditure was being undertaken in fortifications and improving communications on the Baluchistan frontier. After two years he was ordered to attend the Indian Class at Chatham, and whilst there he was promoted Major.

On returning to India he was especially selected to inaugurate Military Works in Poona, where the duties had hitherto been carried out by the P.W.D. This was in 1890 and, including an intermediate absence on furlough, he remained here until 1895, when he was appointed Superintending Engineer at Lahore. Promotion to Lieut.-Colonel came in 1896 and in that year he was appointed Deputy Director-General, Military Works, at Government H.Q., Simla. He held this appointment until 1901, when he became Chief Engineer, Bengal, and a year later was gazetted Chief Engineer, Punjab. In 1903 he officiated as Director-General, Military Works, and in April of the same year this appointment was made permanent, with the temporary rank of Major-General.

In 1906 he was granted the permanent rank of Major-General in the Army and, after completing the five years' tenure as Director-General, retired on an Indian pension in 1908, having entered his

38th year of service, of which 33 were passed on the Indian Establishment.

During the Great War, Major-General Duperier served for three years on the Selection Board of the Inns of Court and Artists Rifles, Officers' Training Corps. His name was published on 25th March, 1919, in a list issued by the War Office as having rendered valuable services in connection with the war.

On 20th November, 1922, he was gazetted a Colonel Commandant of the Corps of Royal Engineers.

These are the facts of General Duperier's service. There are few of his contemporaries still living who knew him intimately during his long and valuable service in India, but it is certain that all who knew him during this period had nothing but kindly memories of him and of his work. Brigadier-General J. A. S. Tulloch, C.B., C.M.G., who served under him at Simla, writes: "He was a most pleasant man to serve under—nothing ever ruffled him. A thorough gentleman in all his dealings and to be trusted to do the fair thing. I think everyone liked him."

It is for his services subsequent to his retirement that General Duperier will be remembered by the present generation.

In 1924, on the death of Sir George Scott-Moncrieff, he was elected to succeed him as Chairman of the R.E. Charitable Fund, having served on the Committee for nine years previously. He continued to guide the Committee in their administration of the Fund to the time of his death, his interest in the work never flagging. Many hundreds can testify to the value of his work in this capacity. When, very shortly before his death, he was persuaded (most unwillingly) to leave London for a rest from guns and bombs, he was insistent that his absence must not extend beyond a month, and he was most anxious to resume his attendances on this and on his other committees.

Few will realize the individual attention that he gave to the cases with which the R.E. Charitable Fund had to deal, and his brief reports at the Annual General Meetings show how wide those dealings were. He would take the greatest pains to become fully informed of any difficult case, and his decisions were invariably based on most careful thought.

While the R.E. Charitable Fund was his chief interest, it was far from being his only one. As a Vice-President of the R.E. Old Comrades' Association he took a most active interest in the Association, and all Corps' activities, and especially their charitable efforts, received his whole-hearted support. He was Vice-Chairman of the Committee of the Royal Cambridge Home for Soldiers' Widows, at Kingston-on-Thames, and there, too, the individual details of many of the cases that came before the Committee—and always the full

details concerning R.E. widows—were his particular care. He was also Chairman to a Cripples' Home in Church Street.

There are few who can be said with certainty to have had no enemy, yet this is undoubtedly the case with General Duperier. He was extremely modest and never one to push himself forward, and it may be that he was not therefore very well known throughout the Corps but those who knew him came to love him, and all who have at any time sought his advice and help know how unstintingly he gave both, and after what careful consideration. He was always patient, always cheerful and blessed with a quick sense of humour. His amazing youthfulness, which persisted to the day of his death, deceived many as to his real age. He was active up to the end, and his mind was as quick and clear at 89 as it had been a quarter of a century before.

He died quite suddenly on October 10th, 1940. He and Mrs. Duperier were staying with their daughter, Mrs. R. S. Maclagan, at her home at Camberley. They had two daughters, the elder the wife of the late Colonel R. S. Maclagan, C.B., C.S.I., C.I.E., R.E., and the second the wife of the late Lieut.-Colonel F. E. H. Daniell, Seaforth Highlanders. Two grandsons, M. D. Maclagan and K. F. Daniell, are serving in the Royal Engineers, and a third, R. D. Maclagan, in the Seaforth Highlanders.

MAJOR-GENERAL PHILIP DE FONBLANQUE, D.S.O.

THE late Major-General Philip de Fonblanque was born on the 16th November, 1885, and was son of L. R. de Fonblanque, of Guildford House, Farnham, Surrey. He was educated at Rugby and went to the "Shop," and from there he was gazetted into the R.E. on the 23rd March, 1905. In 1911 and 1912 he served in Hong Kong with the 25th Fortress Company, and in 1913 he was Staff Officer R.E. to the Chief Engineer. He returned home in 1914. In November of that year, he was appointed adjutant of the 19th Divisional Engineers. He then passed to the command of the 128th Field Company and for him this was one of the happiest and most cherished periods of his service in the R.E. After the war, the "128" formed their own association. To reciprocate the feelings of their former company commander, the members elected General de Fonblanque to be their first President, and, fostering that real warm spirit of comradeship among those who belonged to his old unit, he held this post until the day of his death. He served not only with the British Expeditionary Force, but also with the Italian Expeditionary Force, where he was Staff Officer to the Engineer-in-Chief. He was twice mentioned in Despatches and was awarded

Maj-Gen Philip de Fonblanque DSO

the D.S.O. In 1920 he went to the Staff College and afterwards held various staff appointments, among them both "G" and "Q" at the War Office. In 1930 he went to India, where he served as C.R.E. Lucknow and Delhi and also gained N.W. Frontier Medal 1930–31. He returned home in 1934, when he was appointed A.A. and Q.M.G. Aldershot, and from there he went as Brigadier i/c Administration, Scottish Command, where he served until the outbreak of the present war.

So, on this record of his past service, there was little surprise that he was appointed, on the 3rd September, 1939, to command the L. of C., B.E.F. It needed a commander with a broad outlook and wide vision. The selection, as it proved, was an admirable one. There is no more arduous and intricate command than that of the L. of C. of any Expeditionary Force, and the L. of C., B.E.F. in 1939 presented outstanding difficulties. The Commander was at the beck and call of all and sundry, with demands from the front and restrictions from home. This was the position that de Fonblanque had to face in September, 1939, when he took over command, and how well he did it!

The most able Staff Officer, yet he possessed all the qualities of a great commander. He was a master of detail but he could decentralize the voluminous amount of work that fell on his broad shoulders. He was never out of the picture. He knew where everything was, where it had come from, where and how it would move, if and when wanted. He was ready for any emergency and he was always prepared to meet one before it really developed.

He was as brilliant as he was unassuming, and he possessed a charm of manner, outstanding ability and a character that endeared him to all. He had the keenest of brains, a most alert mind, and enjoyed those rare gifts of writing and speaking. Every letter and document which he drafted—and with such speed—were masterpieces of the English language—clear, intelligible, brief and to the point—no ambiguity, and they went to the core of the subject under review. How his letters opened the eyes of some of his interrogators to sound common sense!

In a conference he was also a master. He was ready to hear everybody's point of view, but it had to be brief. Kindly—very kindly—he would dispose of the verbacious bores who somehow seem to gain access to any military conference room. He was quick to sum up and so sound in judgment.

Though he was one of the most hard-working men on the L. of C., he would always have time—or make time—to see any member of his staff, however subordinate, who came to see him. Never irritated by such intrusions, as some would have been. His usual greeting was "Come on, old boy. What have you got?" An interested and sympathetic listener to other people's problems; they became to them small and were solved almost at once.

His subordinate commanders on the L. of C. also came to him for help and advice with their many troubles. It was not only because he was extremely capable and efficient, but he was so unfailingly sympathetic and understanding in other people's difficulties. He showed such toleration, patience, and human sympathy. So all came to him when in doubt, and no one ever went away empty-handed.

He ran a most "efficient show."

But he was a sick man—a very sick man—but that was only known to a very few. Complain he never did. The worse his sufferings, the more courage he displayed so as not to depress those around him and who worked with him. He mastered constant physical suffering in devoting himself with unflagging energy to his first great task—his Duty. What an indomitable spirit and what self-denial he displayed to attain this end! At times his Staff thought he would never stand the strain that he bore.

The "Little Man" as he was affectionately known to many, was an outstanding personality to serve with and live with. He had the most wonderful sense of humour. He would reduce to the ludicrous, in the most kindly way, so many remarks of his Staff and friends which had been passed in all seriousness. He never missed seeing the funny side of life as well as the serious. He was adaptable to both.

He was an outstanding host and his mess must have been the happiest in the B.E.F. No single member ever escaped his kindly "leg pulls." His guests, and they were legion, went away infected with this same atmosphere of boyish happiness.

He was never more at home than when he was across a horse, or better than after a spell in the saddle. Wonderful hands and a perfect seat. It did one good to see.

He was a deeply religious man—an ardent Catholic—not one of the bigoted type.

He diffused his love of God to all creeds—C. of E., the Church of Scotland and all other Denominations.

He was very conscious of the work of the Chaplains Department, realizing its direct importance to the morale of his command. To Chaplains, like to the rest of his Staff, he gave every encouragement and support. He was intensely interested in the moral and spiritual welfare of those under him, and he urged the necessity of time being allotted to this side of a man's life.

He seemed to be truly inspired. There were days when his closest associates thought he would break down. The writer well remembers a certain Saturday when he was persuaded to go to bed, tired and exhausted, and the worst was expected. Sunday at breakfast he returned from Mass. What a transformation! Smiling, happy, abounding with joy, energy and renewed spirits. This infected all his Staff. It is impossible to describe with a pen the change in the

man, yesterday a wreck—to-day the shining example of a Leader. The atmosphere he brought with him from Mass infused and infected all others, whatever their religion. He imbued happiness to all around him.

Then came the dark days of the evacuation. The B.E.F. had gone from Dunkirk. The L. of C. were in a precarious position. Big and quick decisions had to be made. Orders and counter-orders he received in rapid succession. Yet he was obdurate in doing what he thought to be the right thing in such a critical time. It was entirely due to his foresight, imagination and the full appreciation of a very difficult situation, that so much of the L. of C. Stores, Ammunition, Transport, etc., were evacuated back to England, in addition to the whole of the personnel. History will prove how very right he was in taking the big decisions he did.

So the L. of C. was evacuated. But this proved to be the death of Philip de Fonblanque. Exposed for two nights on the deck of a trawler en route to England, he developed a chill. This aggravated his sickness, from which he never recovered. He passed to his great reward on 2nd July, 1940, only a few days after he had returned from France.

His L. of C. Commanders and Staff had, after the evacuation, been collected in an office in London, to wind up with him, the final business of the L. of C. They were staggered and numbed when they heard of the passing of their beloved Commander.

Dickens when he penned

> " Have a heart that never hardens
> A temper that never tires
> A touch that never hurts "

aptly described the " Little Man," Philip de Fonblanque.

He was to have been awarded the C.B. for his distinguished service as Commander of the L. of C., but this award is not one that is given posthumously. He was " Mentioned in Despatches " in the *London Gazette* of 20th December, 1940.

In 1916 he married Stella Mary Augusta May, daughter of Sir F. H. May, G.C.M.G., and there were two daughters and a son of the marriage, all of whom survive him.

COLONEL SIR GEORGE H. WILLIS, C.I.E., M.V.O.

BY the death of George Henry Willis the Corps of Royal Engineers has lost a very distinguished member and an officer of outstanding enterprise and ability. Son of the late James Willis, Esq., I.S.O., of Ealing, George Henry Willis was born on 21st October, 1875, was educated at St. Paul's School, and entered the Royal Military Academy at Woolwich in 1893. He received his commission on 3rd August, 1895.

After two years at the School of Military Engineering, he went through the courses of Submarine Mining and Brennan Dirigible Torpedo, at Plymouth and in the Isle of Wight, and proceeded to India in 1900. He was first stationed at Aden (which at that time was administered from India), and was then transferred to the Indian Submarine Mining Company at Karachi: from Karachi, he went on to Army Headquarters at Simla, where he worked in the office of the Director-General of Military Works from 1903 to 1907. While at Simla he was responsible for the design, supervision and inspection of electrical and mechanical installations of the Army in India, work which necessitated a good all-round technical knowledge. At Simla he was also Secretary of the United Services Institution of India. He was promoted Captain on 3rd August, 1904.

In 1907 Captain Willis was appointed Deputy Mint Master, Bombay Mint. He was transferred to the Calcutta Mint in 1909, where he officiated as Mint Master until 1911. During this period much work of special interest was undertaken by him: he carried out the complete electrification of the Mint, all machinery being converted from steam to electric drive, thus greatly increasing the potential output of the Mint, and reducing running costs. The Mint also struck a quantity of foreign coinage in addition to its output of Indian coin.

Perhaps the most interesting work carried out in this period, however, was the manufacture of the thrones for the King's Delhi Durbar of 1911, to be used by their Majesties King George V and Queen Mary. The thrones were actually facsimiles of other thrones of Georgian design, which had been made in 1875 of wood cased with thin sheet silver. The new thrones made by Captain Willis were of cast silver obtained from the melting of about 96,000 old rupees, and the weight of the finished thrones, with their silver footstools, turned out by a curious coincidence to be 1,911 lbs, the same figure as that of the year of the Durbar. This work required great care and skill, owing to the elaborate design, and some of the pieces of the thrones, such as the massive lions forming the arms of the King's chair, required special treatment in casting. After the

Col Sir George Willis Kt CIE MVO

thrones had been cast, they were chased and engraved, and were then gold-plated by electrical process. They were finally despatched to Delhi in pieces, where they were assembled and upholstered.

Captain Willis also undertook the striking of the special Durbar medals, of which 200 were struck in gold and 27,000 in silver, taking 16 weeks from the time the dies were ready.

For his work during this period in the Calcutta Mint, Willis was awarded the M.V.O. in 1911.

With the exception of a short time in charge of the Bombay Mint in 1912, Willis continued at Calcutta till 1915. He was promoted to the rank of Major on 30th October, 1914, and in 1915 he was transferred to Bombay, where he remained as Mint Master till he retired from the Indian Mints Department in 1924.

Major Willis was thus in charge of the Bombay Mint during the Great War, and during the war period he was called on to carry out very important work for the State. With the huge population of India, where the bulk of all payments are still made by currency notes or coin, the quantities of notes and coin in circulation are very great, and the Indian Mints are the largest in the world. The Great War enormously increased the demand for coin, particularly silver rupees, and it became a matter of vital importance to maintain the supply without fail, in order to finance the State and to maintain the exchange rate of the rupee. The Indian Mints were therefore called on for special exertions.

In these circumstances, Major Willis, as Mint Master, Bombay Mint, was faced with the difficulty that this Mint was still operated by very old steam plant, the replacing of which by electric drive had to be postponed owing to the war. Nevertheless, he succeeded in keeping the Mint at full output during the years 1916-20, for most of which period the plant worked for 20 hours a day. This was effected only by unremitting attention to the old steam plant. The number of hands employed was as high as 2,300, and the output of the Bombay Mint in these years, of silver rupees alone, reached the huge figure of about 740 millions, with the phenomenal peak output in 1918-19 of 246 millions. In addition, large quantities of cupro-nickel small coin were struck, as well as foreign coinage for Egypt and the Straits Settlements. The annual outputs of the Bombay and Calcutta Mints reached record figures far in excess of those ever attained by any other Mint in the world. The Bombay Mint at this time also handled great quantities of gold on behalf of the Government of India and of the Bank of England.

Major Willis also carried out special war work during this period, including the manufacture of 750,000 driving bands for shells, standard gauges for rifle and shell manufacture, the building of ambulance and motor bodies, and the training of Indian drivers.

These remarkable achievements in the face of difficulties could

not have been attained without the great organizing power and ability which Willis brought to the task, and for his fine work he was awarded the C.I.E. and mentioned in despatches.

Major Willis also undertook other works of importance while Mint Master at Bombay. He built and equipped a gold refinery in 1919; this dealt with the whole of the output of raw gold from the Indian mines, and gold from other sources, and it became of great value to the Bombay bullion market. In the Bombay Mint, he coined about 2 million "gold mohurs," a new coin of the same size and fineness as the sovereign. He also built and equipped for the Royal Mint, London, a small Branch Mint for stamping sovereigns: the preliminary processes of melting, rolling, cutting, etc. were carried out by the Bombay Mint, and the annealed gold blanks were delivered to the Branch Mint for stamping. All gold coinage ceased shortly after the war, however, as gold was withdrawn from circulation in the Empire.

Willis was promoted to the rank of Lieut.-Colonel on 31st December, 1921 and to Substantive Colonel on 31st December, 1925.

Perhaps Willis' greatest work was the Indian Security Press. Shortly after the Great War, the Government of India took up the question of printing their own currency notes, stamps, etc., which had hitherto been supplied from England. Willis had already made a study of the technique, and was sent on deputation to England to report on the possibility of such printing in India. In consequence of his thorough report, it was decided to build the Indian Security Press, and a suitable site was found at Nasik Road in the Bombay Presidency. Colonel Willis was entrusted with the work of lay-out, design and equipment.

Starting as it did on a very big scale without previous experience in India, this was a very comprehensive undertaking, involving difficult problems. The site had been chosen as being suitable in respect of climatic and other special conditions, but was not near any large town. In addition to the detailed work of designing the Press itself, it was therefore necessary to arrange extensive accommodation for workmen and staff, complete with water supply, sanitation, and roads, to collect and train the personnel, and virtually to construct and organize a complete new village and community where little but a bare plain had existed previously. Special arrangements had also to be organized for storage of the valuable products of the Press, and for guarding against theft and leakage. As regards the technical processes, some experts in England had advised that this specialized printing work would be difficult or impossible in the climatic conditions of India: this did not deter Willis, and he shouldered the heavy responsibility of recommending the Government of India to go ahead with the project.

The construction of the Security Press started in September, 1924,

and the actual printing of stamps was commenced in 1925. In August, 1926, the section for printing currency notes was started, and was completed in 1928, in which year the Central Store was also added. All difficulties were overcome, and the products of the Press are consistently of the highest quality. The annual output is :—About 700 million currency notes, 1,000 million stamps, 270 million stamped postcards, 270 million embossed envelopes, and other special work has more recently been added, including some 4,000 million match banderols.

The carrying of this great project from its initiation to a successful conclusion required exceptional technical ability, driving force, and organizing power. The Security Press stands as a monument as Willis' greatest achievement, and a well-earned knighthood was conferred on him in 1928 for his very fine work. On the completion of the work he was appointed Master of the Security Press.

Apart from his technical abilities, Willis was a man of wide general knowledge and many diverse interests. During the latter part of his career in India he served in public work of many kinds outside his normal professional duties. He was a Member of the Re-organisation Forest Department Committee, President of the Institution of Engineers in India, Chairman of the Boiler Commission, Chairman of the Victoria Jubilee Technical Institution, and Chairman of the David Sassoon Reformatory Institution.

He retired from the Army in 1932, but remained for another 2 years in India as Master of Security Printing, when he finally retired from India and returned to England.

Willis was not a man content to remain idle after retirement. He served as a Director of the famous firm of Messrs. Portals Ltd., makers of the special paper used by the Bank of England. He also served as a Member of the Council of the Institution of Mechanical Engineers, and was Chairman of the Southern Branch. The following is an extract from a brief notice which appeared in the *Journal of the Institution of Mechanical Engineers.*

> " By virtue of his command of the science of heraldry he gave the Council valuable advice on the Coat of Arms and its design, even at great inconvenience to himself during his last illness. The Institution has sustained a great loss, and Sir George will long be remembered with gratitude for the unselfish devotion which always attended his services to the Institution."

George Henry Willis married at Aden in 1900 Gertrude, daughter of C. H. Bennett, Esq., of Plymouth : Lady Willis was a well-known figure in Bombay society. He left three daughters ; Violet Edith, married to Commander W. Shewring ; Mavis Fanny, married to Major C. A. Suther ; and Joyce Gertrude, married to L. Kann, Esq.

The sympathy of the Corps will go out to Lady Willis and her children in their great loss.

Willis was a man of remarkably quick brain and rapid decision, and naturally gifted with the quality of leadership. A man of great kindliness and human understanding, he also possessed a keen sense of humour. He therefore had a wide circle of friends, to whom he was known affectionately as "George Henry." Thoroughly at home in any kind of society, he was a most interesting man to meet. He was a highly trusted servant of the State, and his subordinates trusted and admired him. On learning of his death in July, 1940, Lt.-Col. O. FitzMaurice, his successor as Master of Security Printing, published a Special Order, from which the following is an extract :—

> "The Master has learned with great regret of the death of Colonel Sir George Henry Willis, C.I.E., M.V.O., late R.E., at the age of 65. Sir George Willis, was the Father of the Security Press, the Currency Note Press and the Central Store at Nasik Road . . . . He brought them into being, and ordered the daily life of the large community he planted there. He was universally loved and respected, and he did many quiet and unobtrusive acts to assist the needy. The affection in which he was held was demonstrated by the great farewell accorded to him when he and Lady Willis left Nasik Road in 1934, after 10 years of hard work here following on his Mastership of the Mint. His memory will never be forgotten and he has left a fine memorial behind him . . . . The Master respectfully tenders to Lady Willis and her daughters the deep sympathy of all the Staff and employees."

These words constitute a very fitting tribute to the high character and qualities of Sir George Willis, and to the passing of a fine spirit and a distinguished Officer.

R.E.S.

MAGAZINES.

THE JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA, OCTOBER, 1940. VOL. LXX NO. 301.

The Journal eases the task of the reviewer by providing a short summary and criticism of its component parts.

The value of mechanization in assisting to solve the defence problems of India, by Major D. F. W. Warren, 8th Punjab Regt., was selected by the judges as the best submitted for the Gold Medal of 1940, though no medal was actually awarded. The main point brought out is the need of vehicles for carrying pack animals up to the point where men have to de-bus—otherwise in the last stages of an advance, troops have to be burdened with guns, ammunition and equipment, with consequent loss of mobility.

The morale of the Indian Army is the subject of another very frank article. The sepoy must be brought to consider himself part of the national army of India, and of India as part of the British Empire. The attachment of the sepoy to his B.O., which may be said to have been the foundation of his morale in the past, is perhaps not sufficiently stressed in the article.

Messes and Clubs contains what the older generation will consider the revolutionary doctrine of abolishing regimental messes. Expense to the officer is the main reason given, and it is impossible to deny its cogency. In large stations there would be combined messes, and in smaller ones residential clubs and chummeries. Half the Government allowance could be saved, and the other half devoted to the upkeep of equipment designed for field service messes.

Learning Persian notes the difference between Persian learnt in India for the H.S. and the L.S. exams, and the language as spoken in Iran; most officers who have been in the country will endorse that view. It is besides an interesting account, with many amusing anecdotes, of life in Iran at the present time.

The War in East Africa, by an officer who has served both in the I.A. and the K.A.R., is of special interest. Its subtitle is *A role for the Indian army* and it envisages the use of Indian troops, mainly on the Kenya—Abyssinia border. Two items out of many may be cited. The author met some Italian officers in Somaliland, one of whom in confidential tones asked him "What did you do to be sent out here?" The second relates how a battalion of the K.A.R. was disbanded in 1913—one wonders by whose orders. The men then offered their services to the Germans, under whom they fought against us well and bravely until the armistice. At the end of the campaign they were months in arrears of pay to the Germans, which arrears the British government very wisely paid. The men then re-enlisted in the K.A.R., and as late as 1928 some were to be seen wearing both the Iron Cross and the African G.S. Medal.

Two other articles are worth study, *Political Commissars in the Soviet Army* and *Propaganda Problems*.

One does not look for a thriller in a military magazine, but *A study in Russian Strategy* would make a fine cinema show of a rather macabre type.

F.C.M.

THE MILITARY ENGINEER.

(*November-December, 1940.*)—*The Engineer and National Defence.* By Major-General J. L. Schley.

In this address to a meeting of military and civil engineers, the writer describes the rôle of Engineers in National Defence. Defence is divided into three general headings: (1) Engineer troops (" combat arms ")—now more important than ever; (2) Construction of barracks, hospitals, transportation routes and fortifications; (3) Supply of war materials and equipment. Just before entering the World War, the United States had 255 Engineer officers in the Regular Service; in November, 1918, there were 10,700. Since then a force of 120,000 officers of all arms has been built up and, of these, about 8,000 are in the Engineers.

The burning problem confronting the Corps of Engineers at present is the lessons to be learnt from the great events in Europe during the past year. What has made the success of the German *Blitzkrieg* possible? In the German Army the *Pionierkorps*, the counterpart of the Corps of Engineers, has played a leading rôle in the result. In German doctrine, as in that of the U.S.A., the Engineer has two great functions: on the one hand, he makes passable, and keeps passable, the roads over which our own forces advance; and, on the other hand, he makes impassable, and keeps impassable, the roads over which the enemy may advance.

As an illustration of the ease with which the Germans overcame the defences of Flanders, the writer mentions the attack on the fort of Eben-Emael in May, 1940. This fort, one of the strongest Belgian forts behind the Meuse River and the Albert Canal, fell before the assault of a German Engineer battalion within 30 hours of the beginning of the battle. Its fall sealed the fate of Liège and made the line of the Albert Canal untenable.

The ease with which the crossings of some formidable rivers were forced is still a puzzle, but it is partly accounted for by the delay in issuing orders for the demolition of important bridges. The action of parachute troops and of Fifth Columnists may also have helped.

Flood Control in New England. By Major H. J. Woodbury.

A series of projects is here described, accompanied by sketch maps and photographs, showing works completed or in progress for the control of floods in New England. The rivers brought under control are the Winooski, Merrimac and Connecticut Rivers. The general principle is the construction of dams across some of the tributaries of these rivers, with spillways and discharge valves. Each dam impounds a large volume of water, so that the unregulated flow of the river in flood-time can be reduced to a regulated flow that will not damage the channel.

The dams to be constructed are, in general, rolled earth-filled embankments which are to be operated as either retarding or detention reservoirs. Consideration is given to the de-synchronization of flood peaks at the principal damage centres by means of gate-controlled outlets. The dams on the Winooski river vary in height from 65 ft. to 155 ft., with top widths ranging from 20 ft. to 35 ft. The slope of the fill on the upstream side was fixed at 1 in 3, that on the downstream side at 1 in 2½.

The Army (Sea) Transport Service. By Major T. J. Weed and R. W. Charles, Naval Architect.

The Army Transport Service began its career with the movement of troops and their impedimenta to Cuba. Since that time it has been the Army's connecting link between the United States and the Philippine Islands, China, the Panama Canal Zone, Hawaii and Puerto Rico. For many years the Army Transport Fleet consisted of 17 vessels. Seven of these vessels were in operation when America entered the World War. From these a great fleet was built up, until, on the 1st November, 1917, it numbered 512 vessels with a total dead weight of 3,251,000 tons.

At the present time the fleet consists of ten vessels, now getting old. A new transport, modern in every respect, is nearing completion. It will be specially equipped for service in the tropics.

The First Army Manœuvres. Impressions of the Two-Sided Army Exercise. By Lieut.-Colonel J. H. Carruth.

The First Army manœuvres, held in the Watertown-Plattsburg area of northern New York during August, 1940, constituted the largest concentration of troops for training purposes during peace-time in the history of the U.S.A.

The article is mainly devoted to the work carried out by the Engineers. It consisted of Map Supply, Marking of Routes, Camouflage, Anti-mechanized Defence and Stream Crossings.

In connection with the bridging operations, the writer was impressed with the desirability of replacing the present light pontoon equipment by a much lighter type of equipment, capable of rapid construction, and designed to carry the loads of the infantry division combat teams. His idea is that the infantry should be closely supported by light artillery, while medium howitzers could continue their support for some time after the infantry has crossed, and could be ferried across later on.

Other suggestions made for modifying the equipment are the following: A few trailers should be provided, designed to transport heavy timbers on the march; a portable type of rock crusher would be useful in engineer depots; the number of heavy machine-guns should be increased from two per company to two per platoon; the combat corps regiment should be fully motorized.

Water Supply for Military Purposes. By Lieut.-Colonel H. Miller.

In this paper, presented before the Reserve Officers' Association in Charleston, the writer quotes largely from the *Engineer Field Manual*, 1932, which he criticizes in one or two respects. We should agree with him in considering the absolute minimum of water for men in battle (for not over three days) of one-quarter to half a gallon a day as inadequate, especially in very hot climates.

Various types of mobile purification units have been adopted for the United States Army, the latest being the M2 Unit designed by the Corps of Engineers. It has a capacity of 5,000 gallons per hour, and supplements the 900-gallon-per-hour units assigned to the divisional engineer battalions. Each M2 unit is understood to cost about $30,000.

For distribution in permanent or semi-permanent camps 2-in. mains are suitable; 4-in. mains are required for fire protection.

For storage purposes 500-gallon trucks and 2,000-gallon tank cars are used on light railways. 4,000-gallon canvas water tanks, usually sunk 4 ft. into the ground, are used at water points in the field. Railway water tanks require a capacity of 25,000 gallons.

What Does It Mean to You?

Lieut.-Colonel F. W. Gano discusses the interpretation of Mobilization Day, commonly known as M-Day, from two points of view, *i.e.*, the purely military point of view, and the industrial point of view. To a person engaged in an industrial occupation he offers the advice: "Stick to your job. Become as expert as is practicable. Develop helpful avocations in your spare time and be ready to answer a call for other service when and if it comes."

Engineers in Combat.

Lieut.-Colonel D. B. Adams describes, mainly from his own observations and experience, the development of Engineer troops, their mission and equipment, during the past 23 years.

He divides the period into three parts. He was with a unit of combat Engineers in France in 1917 and 1918, and describes the work carried out by that unit, mostly in the front line.

The changes that took place during the twenty years following the war which ended in November, 1918, were gradual and remained for the greater part in the theoretical state. Weapons were improved, mostly on an experimental basis. The mechanization of the army increased, particularly on paper.

Early in 1940 we get the streamlined division, in which the Engineers were given

numerous changes in organization, in equipment and in missions. The writer, however, doubts whether the present-day Engineer combat battalion will be adequate to cope with the calls likely to be made upon it under conditions of actual warfare. He approves of certain additions made to the equipment, viz., a bull-dozer (of which an illustration is given) per company, a compressor per platoon, and a set of assault boats as part of the normal equipment. What is essential is that Engineers should have everything that is necessary to "get the infantry forward."

This Guerrilla Warfare. By Captain B. D. Gill.

This is a plea for a study of guerrilla warfare by regular soldiers. Instances are quoted of the success of this type of warfare in the past.

In the writer's opinion a great mistake that the regular officer has made in the past in combating guerrillas has been the use of great numbers. It is better to use a smaller number and rely upon speed, superior arms, equipment and supplies—above all, speed and continuous action. Captain Gill instances the Boer War and the campaign against Lettow-Vorbeck in East Africa, in both of which the British had a preponderance of 16 to 1, and Kitchener's defeat of the Mahdi with a numerically inferior force. The examples are, however, hardly parallel; the conditions of the campaigns were entirely different.

A.S.H.

REVUE MILITAIRE SUISSE.

(*September*, 1940.)—*Wir zogen gegen Polen.* By Colonel Montfort. A *résumé* of an account of the operations of the Seventh Corps of the German Army in Poland, by its commander, General von Schobert. The chief feature of the account is the overwhelming speed and momentum of the German onslaught in those few days of September, 1939, that the campaign lasted. When one side is so swiftly and thoroughly thrown into confusion, as were the Poles, it is easy to depict the victor's operations in flamboyant colours. There is nothing for military students to dwell on in a one-sided story of this kind. We must wait for the details from the other side.

The German columns—if columns they can be called—pushed into the Polish territory with amazing speed. They broke up the organization and the communications almost at the outset, and made it impossible for the Poles to co-ordinate any operations. To advance and keep on advancing were the orders issued to the motorized troops. Bridges were destroyed far behind whatever line the Poles appeared to be contesting. Tank obstacles were blown to pieces by accurate artillery fire—accurate because there was no opposing fire to disturb it.

As an example of the *Blitzkrieg* method, the Polish campaign of 1939 will stand out, but there is insufficient material yet for valuable study.

En consultant mon dossier "Assistance." By Captain Tapernoux. The author, a company commander, writes of the personal problems affecting his men, their pay grievances, their domestic problems, the "dunning" of many of them for unpaid bills and taxes. The problems solved in our Army by the Command Paymaster seem to fall heavily on the Company Commander in the Swiss Service.

There is a "human touch" in the article.

Commentaires sur la guerre actuelle. For the first time, these commentaries refer to the struggle between Britain and Germany. After remarking that the massed German day attacks had given way to night raids by the end of August, the commentator draws the conclusion that the British A.A. defence has been unable to deny access to the enemy's objectives; that the balloon barrages have failed to act up to expectation; and that the balloons have been destroyed in large numbers! Only by continuous massed air attacks can results be obtained.

These comments, coming three or four months in arrear, are somewhat wide of

the mark. The Swiss, at any rate, are by now awaking to the ever-extending range of our air activities.

(*October*, 1940.)—*L'Avenir de la fortification*. By Colonel Lecomte. "Fortification, permanent as well as improvised, is now going through a graver crisis than that of 1914." This has been only too clearly demonstrated by the failure of the long preparations made by the French to render their frontier impregnable. If their Maginot Line was not directly assaulted, and therefore cannot be said to have been fairly tested, the rest of their line to the sea broke at its Sedan end, at the first attack. In 1914–15, the great fortresses of Liège, Namur, Maubeuge, Antwerp, Novo Georgievsk, Cracow, Lemberg and the rest fell after brief assaults, but the thin lines of wire and trenches, manned by first-class troops, stood up to months of heavy battering.

To-day, such lines are jumped over by air, and dive-bombers can drop their loads with greater accuracy than heavy artillery. Attack by air in the rear can do more damage than any frontal assault.

This is the problem which Colonel Lecomte discusses.

Fortification can never be absolute; its forms are constantly changing, but its principles remain. Tanks and aeroplanes are the decisive elements to-day. Against the former, obstacles and counter-measures can be devised, but against an air attack able to drop its bombs or its troops at any point, the reply is superiority in the air, and this is not within the sphere of fortification.

Colonel Lecomte writes of the problem as it affects Switzerland, who cannot afford the necessary air development to make it possible for her to face her powerful neighbours. She must rely on ground defence, largely reinforced by the natural difficulties of her terrain; but also by as powerful an anti-aircraft defence as she can furnish.

There must be both permanent and improvised elements in the defences; and the defences must be organized in depth. Obstacles, natural and artificial, must be covered by fire from weapons protected against the heaviest air bombs. But such protection usually involves conspicuousness; mobility must be included to reduce the chances of direct hits. Here Colonel Lecomte reverts to the old idea of the mobile gun turret, first tried in 1886 by Schumann. We have the same idea to-day in the motorized gun-mounting. Mobility makes it possible to reduce the amount of armoured protection.

So we come to the position that fortification to-day must be chiefly directed to the prevention of an inroad of tanks, supplemented by anti-aircraft armament to deal with dive-bombers and low-flying attacks, leaving the invasion by air to be dealt with by the air forces.

Colonel Lecomte illustrates his article by describing his ideas for the fortification of a plateau in the neighbourhood of Lausanne.

L'instruction militaire préparatoire. By Major de V. An historical *résumé* of the national training which has been a feature of Swiss life throughout the ages. As far back as the fifteenth century, Switzerland had the largest armed force in Europe, and had built up a reputation for military sturdiness second to none. On countless fields and under numerous leaders, Swiss troops gained fame for their bravery and endurance. They took their training seriously. Up to the Great War, the national obligation to train continued, but the hope that the "war to end war" had been fought and finished led to a slackening of the effort.

To-day, the question of national service in Switzerland is being revised, and in December the Federal Council was to place proposals before the Chambers for the improvement of the preliminary gymnastic training of boys of 16 to 18 years of age, and the musketry training of those up to 19 years.

La bataille des Alpes sur le front de la 4e Armée. By Lieut.-Colonel Pederzani. Under this imposing title, the *Revue* gives a translation of an article in the Italian military journal, *The Armed Forces*. It is little more than a brief summary of the moves and dispositions of the units of the Fourth Italian Army during the brief period of hostilities on the French frontier from June 11th to 25th, 1940. There were

two armies forming the Western Army Group under the command of the Prince of Piedmont, namely the First and Fourth Armies. The former, under General Pintor, covered the front from the sea to Monte Granero, and the latter, under General Guzzoni, from there to Monte Rosa.

There was apparently little fighting; the stab in the back came at the moment when France was reeling under the German blows; but the Italian writer makes the most of the "exploits" of his compatriots.

Commentaires sur la guerre actuelle. The subject of anti-tank defence is reverted to. This has a special interest for the Swiss, who are by no means assured that their mountainous territory would prove secure against invasion by modern tanks. The German achievements in Norway have aroused much interest in Switzerland.

The commentary covers what has often been repeated in the *Revue*, and stresses the importance of obstacles which cannot be overridden by tanks, the form of which can best be tested by actual experiment.

There is no reference to any other of the recent operations.

(*November*, 1940.)—*Forteresses mobiles.* By Colonel Lecomte. Another article by this writer on the subject of mobile gun-turrets, or tank-fortresses, as against fixed defences. It seems as if Schumann's idea of the 1880's is coming into fashion in the guise of the heavy tank; instead of a fixed cupola, why not a self-propelled one? It can dodge the hostile registration by shifting its position. It can be kept hidden and brought suddenly to a chosen position. It can reinforce a weak spot. It has its limitations, but it has great possibilities. In combination with wire entanglements it can quickly form a defensive line.

Questions politico-militaires. By R. A number of questions of political importance exercising the minds of statesmen to-day: the Islamic movement, the Palestine problem, the Mediterranean, the Arabian claims. All of these are inter-related, and all affect the British Empire.

Some interesting notes are given on the old Arabian conquests, spreading from Asia Minor through Egypt, northern Africa and Spain on the west, to Afghanistan on the east.

La bataille des Alpes sur le front de la 4e Armée. By Lieut.-Colonel Pederzani. The continuation of the article begun in the September number of the *Revue*. The second part outlines the Italian operations on the sector Mont Cenis to Bardenecchc, June 11th to 25th, 1940. The French forces in the sector consisted of about 4,500 men, supported by a mixed division and an infantry division, while in reserve were two more divisions. They are credited with having constructed a veritable Maginot Line, but it may be suspected that this term is borrowed to magnify the exploits of the Italian Fascisti. The Italian I. Corps had 2½ divisions in action with another in Corps reserve.

The third part deals with the Mont-Genèvre sector. Here the French had some 4,000 men and 230 guns, with one division in reserve. The Italian IV. Corps of two divisions had another in support.

The operations are only sketched, and no indication is given of the real character of the fighting. One suspects that the French, with the knowledge of the total loss of their cause, were offering very slight resistance.

Commentaires sur la guerre actuelle. The commentary this month deals with the outbreak of the Italo-Greek war. It was expected that the Greeks would be able to offer but slight resistance to their formidable enemy, and that the campaign would last but three or four months.

The opening of the campaign was too recent for the commentator to find any matter for review.

W.H.K.

BELLONA.

Polish Military Monthly, published by the Polish General Staff. XXIInd year. Vol I. (London.) December, 1940.

This number, preceded by a short foreword of General Sikorski, C.-in-C. Polish Forces in Great Britain, is but a continuation of the pre-war *Bellona* which had been published in Warsaw for 21 years. It contains the following articles.

How to Utilize War Experiences. By Colonel A. Marecki.

Every new war brings such fundamental changes of the doctrine, methods, organization and armament, as to make relying on the former war experiences positively dangerous. We are witnessing how, under the pressure of unexpected war developments, the whole military structure based on such experiences has to be changed at the shortest possible notice.

The Polish Army in the 1920 Soviet war just managed to do it at the very last moment, thereby gaining victory. But to repeat it in 1939 war was impossible owing to the lack of time and the shortness of means. As for France, the rigid application of the last-war experiences led to her catastrophe in 1940.

To say, however, that war experiences are rather a burden than an asset would be obviously going much too far. They are, of course, very useful but should never be regarded apart from the conditions under which they actually took place, and which might not occur again, because the enemy, never to be underestimated, will certainly try to change them in his favour. The result, therefore, of these experiences should be continuously remodelled by the appreciation and foresight of these factors. And again, the merits of these changes must be tried out in peace-time by applying not one's own methods but those that are likely to be used by the prospective enemy.

Requirements of the Modern Warfare. By B.M.

The author begins by underlining that the Napoleonic principle of the victory being achieved by a combination of force and speed still holds good and always will. He sets out to prove it by a critical survey of the last wars.

The 1914-18 war started on both sides with an unsuccessful offensive; the French failing owing to the insufficient breaking force (artillery), the Germans owing to the lack of speed (cavalry) in exploiting the success at the decisive point and moment. The subsequent trench warfare was due to the defensive fire power of machine-guns, which were then employed for the first time on a big scale. They made the defence to prevail decisively over the attack and even the tanks, then too slow and too scarce, could not change the resulting deadlock. After these experiences the French accepted for the future the fatuous defensive theory, whereas the Germans successfully developed the idea of a *Blitzkrieg* whose shortness is ensured by an overwhelming total attack.

After short characteristics of the main European armies, the author comes to the Abyssinian and Spanish wars. The latter especially was a rich source of experiment to the Germans who, nevertheless, took the greatest pains to conceal the truth from their prospective adversaries, even by publishing military "criticisms," the sole object of which was to divert attention in a wrong direction and to ensure thereby surprise by the new doctrine.

The Polish-German war of 1939 demonstrated for the first time the power of a modern mechanized army, which could beat the excellent although under-armed Polish troops in 36 days. But even this warning was not heeded by the French who, aided again by German "criticism," attributed the Polish defeat solely to some secondary reasons, failing to notice the main one, the force of the new German war-machine. Consequently, anything that could and should have been done by the French in view of the Polish experience was not done.

The author thinks that, even at that time, the French catastrophe could probably have been avoided by the disbanding of the autonomous French tank battalions and

forming with their tanks ten new mechanized divisions to be thrown from the Maginot Line directly to the north, on German communications. But nothing of that kind happened, the mechanized force remained scattered, and, all efforts to " patch up the hole " by the old methods failing completely, the *morale* of the French soldier was broken, for which the French General Staff must be made responsible. The Maginot Line, even if it would have been prolonged as far as the Channel coast, could not have changed the ultimate result, only the struggle would then have been possibly twice as long and the German losses much greater.

On the other hand, modern fortifications, far from being superfluous, are an absolute necessity for the weaker opponent, under condition, however, that they are never regarded as an impenetrable wall, but only as an obstacle forcing the enemy either to channel his attack or to weaken his onset by losing the time required to effectuate a breach. Behind such fortifications the defender must have reserves capable of resisting the enemy's tanks, *i.e.*, composed of the same arms.

The author's conclusions are as follows :—

Modern war is a war of manœuvre, owing to the now existing superiority of the attack. Modern defence must therefore be based on a modern counter-attack, both sides using the same means, *i.e.*, tanks and aircraft. Operations should be made by mobile units capable of operating independently, even when their outside communications are temporarily interrupted.

Modern war being a lightning one, the importance of the time factor is enormously increased. Quick action, displaying at once the maximum of effort, brooking no delay in execution, but well prepared beforehand, whenever possible, is the essential element of success. The soldiers must be trained and commanders selected from this point of view.

Further, modern war being—

a war of equipment, it is better to have a smaller, but modern, army than a big, but ill-equipped, one ;

a total war, the effort of the whole nation is necessary to gain victory ;

a war of surprise by unexpected doctrine, it cannot be relied nowadays more than at any time upon the experiences of the past wars and a surprise by new enemy methods must always be reckoned with. The doctrine of modern defence, equivalent to that of the attack, is still to be established and might be imposed as a surprise on the adversary.

The Fighting of the 1st Polish Grenadier Division in France. By W. O-cz.

The author gives a short survey of developments in which he personally participated.

The 1st Polish Grenadier Division was formed in France at the beginning of 1940 ; its bulk was composed of Polish emigrants living permanently in France, whereas the officers and N.C.O's arrived for the greater part from Poland after the end of the 1939 campaign. The division was organized on the French model : three Infantry Regiments, two (one light and one heavy) Artillery Regiments (both horse-drawn), a mechanized reconnaissance unit, and a divisional A.T. Battery (horse-drawn). Until the end the division had no A.A. artillery of its own, only one 25-mm. A.T. gun per battalion, an incomplete signal equipment, no optical equipment for A.A. firing and no hand-grenades.

On the 20th of April the division moved into the army zone in Lorraine. On the 28th of May the divisional artillery was put on the front within the Sarralbe–Puttelange sector of the Maginot Line, where it took a prominent part in artillery duels on 11th, 12th and 13th of June, suffering heavy casualties.

On the 13th of June the division took its first position on the Leming–Altviller sector of the second line of defence. On the 14th the French Command, owing to the general bad situation, evacuated the Maginot Line which, incidentally, on this sector scarcely justified its high renown, and was practically not much more than the routine field defences of 1914–18, with addition of some A.T. obstacles. As a con-

sequence of this retreat, the bulk of the division came into contact with the enemy on the 15th of June.

The division belonged then to the French XX. Army Corps and had as neighbours the French 52nd Infantry Division on the left and Colonel Dagnan's Group on the right flank.

As for the general strategical situation it should be remembered that by that time the French Lorraine Army was already practically surrounded, and Dijon and Epinal were to be occupied by the Germans on the 16th.

All German attacks on the 15th were repulsed by the Poles. The artillery and infantry co-operated precisely, notwithstanding the deficiencies of signal equipment, which were already serious, and were to become much worse afterwards.

Although beaten back on the Polish sector, the enemy succeeded in forcing the retreat of the 52nd French Division, thereby exposing the Polish left flank. This retreat caused the loss of the divisional Polish A.T. battery which had been lent to this division and whose crew, firing until the last moment, were for the most part killed, with their commander and the attached 20 French infantry soldiers.

In view of the retreat of the 52nd French Division, the Corps Commander ordered the Polish Division to fall back during the night on a new position within Maizières–Dieuse region.

On the 16th of June the enemy's attack was retarded by the action of the Polish rearguard, the brunt of the dogged struggle being borne by the 1st Polish Grenadier Regiment. Two battalions of this regiment were surrounded and finally fought their way back to the main force with heavy losses, amounting to about 70 per cent in one battalion, 50 per cent in another. The division as a whole lost by the end of this day 15 per cent of its effectives.

During the night from 16th to 17th, the French Corps Commander ordered further retreat to the Marne–Rhine Canal, which had to be the line of permanent resistance. Again three Polish battalions suffered, as rearguard, heavy casualties. In the afternoon, even the main position of the division was temporarily broken through, but the situation was wholly re-established by an attack of the entire divisional reserve, led personally by the Division Commander. The division had on that one day 10 per cent casualties.

Information about the French armistice talk arriving on that day broke down completely the *morale* of French troops, who until now did not realize the extent of their military disaster.

On the next day, the 18th, the enemy's attacks broke through both neighbouring French sectors. Further retreat was ordered by the Corps Commander. The continuous strain of day fighting and night marching told heavily on the division, which lost, from the 15th to 18th of June, 35 per cent of its effectives.

On the 19th, a new German attack finally destroyed the 52nd French Division and the Polish left flank became wholly exposed.

On the 20th, the entire hopelessness of the military situation had became evident and the London broadcast of General Sikorski's order to retreat to Switzerland was received. Nevertheless, the French troops still offering resistance, the Polish Commander, after having consulted his officers, decided that the division had to fight on the French side to the very end.

But already the 21st of June saw the entire collapse of any French resistance, the troops leaving their positions without orders. The Polish division remained alone. To avoid capitulation, the Commander issued on that day the order to destroy arms, to disperse into small groups and to try by every means to penetrate through the German ring to the south of France and from there to get to Great Britain.

Many of these Polish soldiers, amongst whom the commander of the division, General B. Duch, succeeded in doing so after a long Odyssey and they are now in this country with the Polish Armed Forces.

The retreat had extended from Pottelangen to Baccarat, about 40 miles.

Some Soviet Opinions on the Problem of the Modern Defence. By Major S. Jedrzejowski.

This article gives a *résumé* of the latest opinions of Soviet military specialists about the organization of a modern defensive position, the engineering work, the A.T. and the A.A. defences.

THE INDIAN FORESTER.

(October, 1940.)—A Short Note on the Export Arrangements from the Forests in the Sarda Valley, by Mr. Brahmawar, is an absorbing account of an engineer operation carried out by the author and his staff. An area of about six square miles of *sal* forest was due for felling, but most of this lay 16 miles from railhead at Tanakpur, U.P., from which it was separated by two precipitous gorges, where the cost of roadmaking would have been prohibitive.

A path was made above the higher of the two gorges, 4 ft. in width, widened eventually to take motor traffic. The lorries for this purpose were brought up in pieces and assembled on the spot. The gorges were surmounted by a ropeway in two sections, 622 ft. and 248 ft., at an angle of 155°, largely composed of local materials. Owing to insufficient slope the load for the last part of the journey had to be conducted by hand, but the alternative was an expensive power plant.

Below the gorge, for a distance of half a mile, a 2 ft. gravity tramway was used; gravity was used for full trucks, while empties were pulled up by hand.

Then came a stretch of ropeway with a single span of 5,421 ft. ending at the River Sarda, which at this point flows smoothly for 1½ miles, so that it was possible to float the timber. This was done in three ways; by attaching logs to each side of locally-made dug-outs; by making rafts of kerosene oil tins, fastened together with bamboo battens, and by making rafts of *chir* and *sal* sleepers (*sal*, by the way, has nearly the specific gravity of water, while *chir* is considerably lighter).

On the last section of seven miles, a motorable road was made on which lorries could ply.

The total load carried was 240,000 cu. ft., with maximum loads of 9 cu. ft. The whole operation was completed in one season, and the net profit is estimated at Rs. 12,500. The expenditure works out a little over an anna a cu. ft., a very small figure considering the variety of methods of transport. It can be added that no accumulation of timber occurred at any point of trans-shipment; had such happened, owing to the exiguous stacking space available, it would have been hard to avoid a breakdown.

F.C.M.

THE JOURNAL OF THE SOCIETY OF ENGINEERS (INCORPORATED).

(July–December, 1940.)—In this *Journal*, under the title "A One-Man Curve Ranger," a description is given of a new surveying instrument designed by one of their Past Presidents—Mr. A. M. A. Struben, O.B.E., F.S.E., A.M.INST.C.E.—and named the "Struben Curve Ranger," whose main purpose is to enable curves for roads, railways, canals, etc., to be set out simply and quickly by one man, instead of by means of a theodolite, necessitating an observer and two chain-men. It can also be used for observing angles, setting out offsets at any angle, ranging into line between two terminal points, etc.

It is already in use by the Surrey County Council.

F.E.G.S.

CORRESPONDENCE.

THE MIND OF THE SOLDIER.

8, Smoke Lane,
Reigate, Surrey.
January 13th, 1941.

To the Editor, *The Royal Engineers Journal.*

SIR,

In the admirable article on "The Mind of the Soldier" in the December issue of *The R.E. Journal*—the more admirable for the entertaining humour with which the nails of counsel are driven—one observation occurs which should hardly, I think, have passed the Censor and which I feel your able contributor would himself wish to modify if pointed out. I refer to the words on page 516, lines 25, 26 :—"since by custom and right, he (the Soldier) is entitled to a modicum of brutality and licentiousness."

With the principle of non-interference with the private life of the soldier all will heartily agree. It is no part of an officer's job to poke his nose into the soldier's privacy, save in so far as by their ill-effect on military efficiency, bad habits call for correction, as your contributor so well shows. But between that limitation and the positive approval of looseness of living and casting off of moral restraint when out of barracks, apparently conveyed by the words "right" and "entitled" in association with "brutality and licentiousness," surely a wide gulf is fixed. I am not entirely clear that "Sentry's" thought may not have been purely humorous—a little bit of leg-pull in fact—but even so, the passage as it stands is, I submit, dangerous and out of tune with all efforts, for more than a generation past, to raise the standard of soldiering. The British Army of to-day is an Army of Gentlemen. Let us live up to that. I am sure "Sentry" will forgive me the reminder.

Yours faithfully,
T. C. SKINNER,
Lieut.-Colonel R.E. (*ret.*).

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

I am grateful to Colonel Skinner for the comment he made on an extract from the article "The Mind of the Soldier," and to you for giving me the opportunity for a reply.

The point raised is an important one. To what extent should

an officer try to control and guide the conduct of his men in their "private lives" out of Barracks? If it is conceded that he should make the effort, how is he to set about it?

Before considering these points, I would like to make it quite clear that, in common with the vast majority of officers with any experience, I consider that the expression "brutal and licentious" applied to the British Soldier, if applied seriously, is a gross and damaging libel. So much so, that I think it is true to state that it has not been used seriously by people who know what they are talking or writing about for many years, if ever.

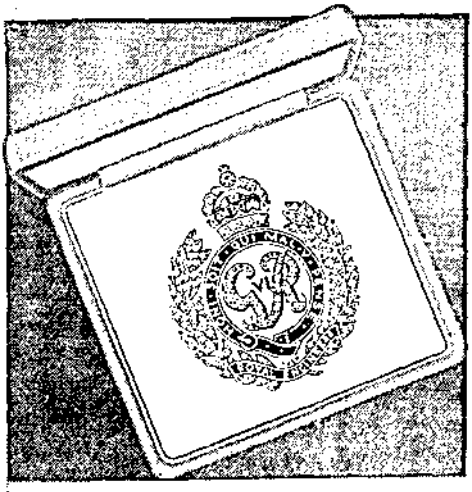
To revert to the first point raised. The two main relevant factors are, first, that the overwhelming majority of British Soldiers come from homes which are generally described by social workers by the adjectives "good" or "decent." We should not be the Nation we are, if this were otherwise. The second main factor is abstract, and difficult to express in words. It really lies in the reactions of a man to a "sermon." It is well known that unasked advice frequently builds up opposition, and has the contrary effect to that intended. If an officer tackles this subject clumsily, tactlessly or priggishly, he will do more harm than good.

The writer's own opinion is that good military "tone" in a unit will *for certain* extend a good influence into every individual's "private life." For this reason, it is for consideration whether it is not best to leave the subject alone—with one exception.

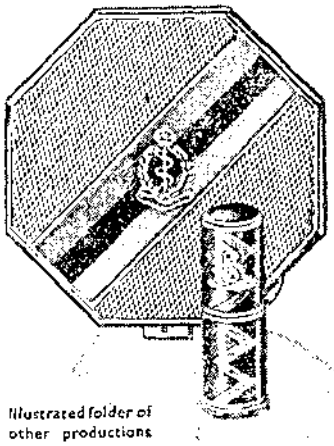
When a young man gets an army number, and puts on uniform, he is a little liable to lose his head. His anonymity sometimes leads him to do stupid things in public which he would never dream of doing as a "civvy." There have been, for instance, cases of a few soldiers in a railway carriage carrying on a loud conversation in "barrack" language, to the scandalization of their sometimes female audiences. It is as well that soldiers should be warned of this tendency, but the warning can best come from an N.C.O. of some age and standing—the C.S.M. if he is a good chap.

If the above discourse is incompatible with the relevant paragraph in the article under discussion, the writer willingly pleads guilty to a charge of loose writing.

I have the honour to be, Sir,
Your obedient servant,
"SENTRY."



The Badge of your Unit



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