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THE INSTITUTION OF ROYAL ENGINEERS.

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The Institution of Royal Engineers,
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THE DEFENCE OF KUT-EL-AMARAH.

By Major E. W. C. SANDES, D.S.O., M.C., R.E.

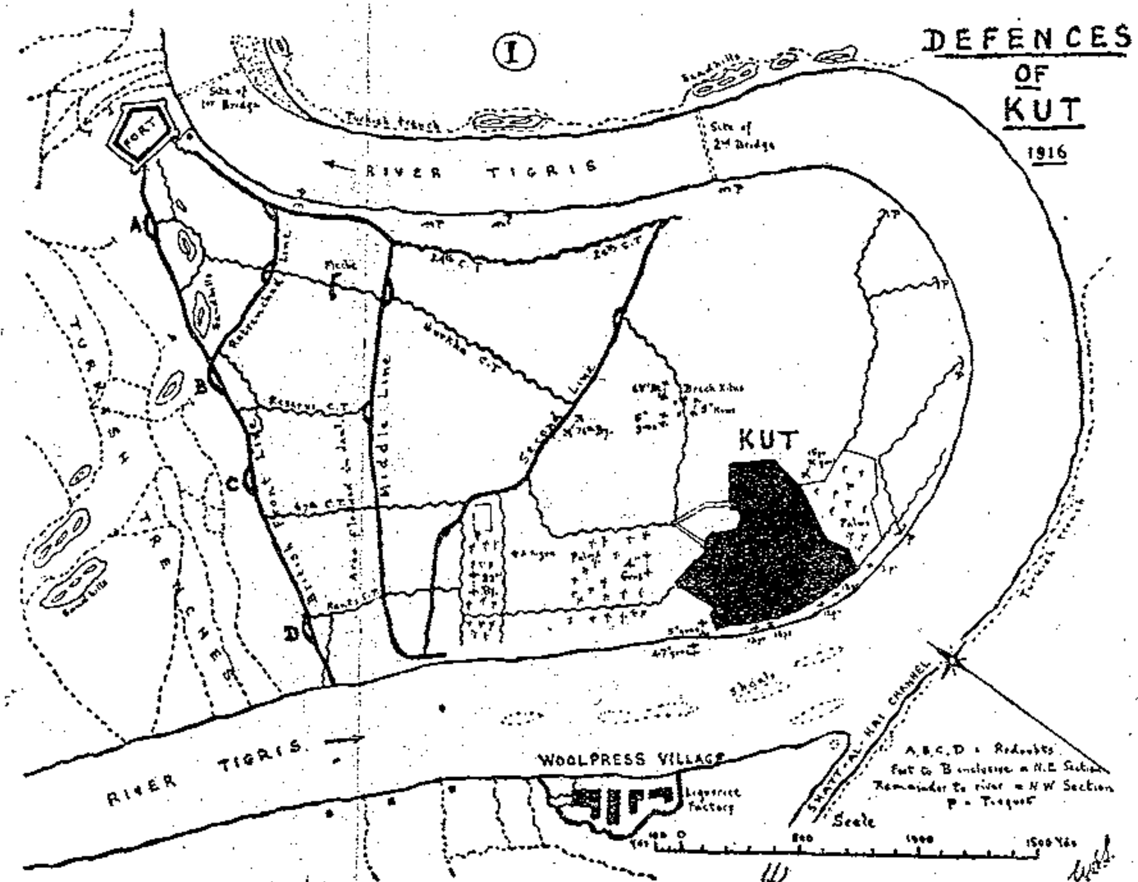
THE battered survivors of General Townshend's force reached the outskirts of Kut-el-Amarah on the 3rd December, 1915, grim, exhausted, and thirsting for revenge, and, ten miles to the north-west, the Turkish legions followed cautiously in their track, warned by the lesson of Ummal-Tabul that there was still fight in the British Lion. Hovering around the flanks and rear of the British force were bands of marauding Arabs, careful to keep out of range, though eager for loot and the murder of stragglers—foul birds of prey waiting to swoop down on the wounded and helpless. Townshend had made a masterly retreat after the fights at Ctesiphon and Ummal-Tabul, and his men had marched seventy-six miles across the desert in two days, outdistancing the foe yet retaining their courage, discipline and morale. It was a fiery test, recalling the retreat from Mons, with sun, dust and thirst in place of German bullets, but British leadership and the grit of the rank and file triumphed in the ordeal. The Turkish wolves licked their wounds, and the pack gathered for a final rush upon the prey.

General Townshend decided to halt at Kut, and to defend it till relieved, in order to hold up the Turkish advance into Lower Mesopotamia. Reinforced by half a battalion of West Kents and the 14th Hussars at Aziziah during the retreat, and by 1½ battalions of Indian infantry on reaching Kut, he found himself in command of 10,400 combatants, of whom 1,500 were cavalry; and, when the cavalry were sent away on the 6th December, he had only 7,400 infantry to defend a front of 2,700 yards across the loop of Kut, to picket three miles of the river bank, and to garrison Woolpress Village across the river. Coming down upon him from the north-west were six divisions of Turks under the German Field-Marshal Von der Goltz, the advanced guard being stronger than the whole British force; and behind him was only the 28th British Brigade, which was then leaving Amarah, 100 miles away. A desperate position if ever there was one!

When Townshend entered Kut there were practically no defences other than those designed to resist an attack by Arabs, viz., a line of four blockhouses across the Kut loop of the Tigris, connected by a wire fence, and ending in a walled fort at the north-eastern extremity on the river bank, downstream of the town. Townshend had been so uniformly successful during his advance, the nucleus garrison at

Kut was so small, Arab labour was so unsatisfactory, and the time so short, that no defensive system was ready for the retreating British force on arrival which would enable it to resist a determined attack by large masses of Turks with good artillery. By the grace of God, the determination of our men, and the excessive caution of the advancing Turks, there was just—and only just—time to make a first, though frail, barrier against the enemy's onslaught before it came. As the tide of the enemy rose and his waves mounted higher, so was that frail barrier, the front line, strengthened and supported by other lines; and when, on Christmas Eve, the storm broke from the north-east, the Fort, at that end of the front line, was just—and only just—strong enough to withstand the shock and save Kut. There can be little doubt that, if the attack on the fort had taken place a week earlier and if the enemy had backed up that attack with a determined assault on the north-west section of our defences upstream of Kut, pressed home regardless of losses, the garrison would have been overwhelmed and Kut would have fallen in December. Why, then, did he delay his attempt and fail to use sufficient force? Chiefly, I think, because of his respect and fear of British prowess and tenacity, but partly owing to the difficulty of transporting sufficient ammunition from Baghdad to Kut in the time available, and also because of the advice of Von der Goltz.

Now the German Field-Marshal was a cool and experienced strategist and a student of military history. He remembered the fate of Bazaine in Metz and of Massena in Genoa. He knew that an immediate assault on Kut, driven home with masses of bayonets, would probably lead to victory, but only at the cost of very heavy casualties which the Turks could ill afford when so far from Anatolia. He guessed that England would surely send large reinforcements to Mesopotamia to retrieve the ill-fortune of the recent British advance, and that he would need all his resources to meet that invasion. And lastly, he was well aware that, if he could contain Townshend till the river flooded the country in January, the chance of the rescue of the beleaguered force was small indeed. The impetuous young Turkish general, Khalil Pasha, leading by the nose his vacillating superior, Nur-ed-Din, wished to avenge the tactical defeat of his countrymen at Ctesiphon, and the fiasco at Ummal-Tabul, by an immediate assault in overwhelming numbers; but the wily old German had his way, and such attacks as were made prior to Christmas Eve were not serious, while the serious attempt on that day was directed only against the fort and was not pressed strongly elsewhere. Von der Goltz saw that the main body of his enemy was only then assembling in Lower Mesopotamia and that Townshend's troops would soon be of minor importance, so he rightly prepared to strike at the heart rather than the head of his foe and to husband his troops for that purpose. Thus the British were allowed time sufficient to organize



DEFENCES OF KUT
1916
I
FORT
RIVER TIGRIS
KUT
WOOLPRESS VILLAGE
Liquorice Factory
SHATT-AL-HAI CHANNEL
Site of 2nd Bridge
Site of 1st Bridge
Middle Line
Front Line
Second Line
A
B
C
D
A, B, C, D = Redoubts
Scale

their defence and strengthen their position, unsatisfactory though it was.

General Townshend had four weak brigades—the 16th, 17th and 18th Brigades of the 6th Division, and the 30th Brigade of the 12th Division—and there was only one British infantry battalion in each Brigade, the remainder being Indian. The position of his front line was more or less determined by the existing line of blockhouses and the fort. The area thus enclosed gave a suitable space for manœuvre. The blockhouses temporarily covered the digging operations in the 2nd Line (see *Diagram* I), which had already begun, but they were demolished on December 7th when the work was well advanced on the four redoubts A, B, C and D, which were to replace them, by which date, also, the 2nd Line defences were almost complete. By December 12th the redoubts had been finished, and, three days later, they had been linked up with traversed trenches to form a continuous front line. Meanwhile the defences of the fort had been improved, and the village of Woolpress fortified, so that by the 15th December, only 11 days after the troops had actually entered Kut, there were two strong lines of defence to withstand the Turkish attack. The defensive system was then completed by a "Middle" Line, which was dug before Christmas, and a "Retrenched" Line (see *Diagram* I), which was excavated immediately after the abortive and desperate assault on the fort on Christmas Eve. Communication trenches had to wait their turn. For a long time there were very few of them—far too few to permit of reinforcing the front line hurriedly except by an advance across the open plain—but each work had to be viewed in the light of its immediate urgency and the most essential works were the fire trenches.

The sections, or zones, of defence around Kut were allotted as follows (see *Diagram* I):—

(*a*) The *North-east Section* (or zone) of the land front to the 17th Brigade under Brig.-General Hoghton. This zone included the fort and extended in the front line to Redoubt B, the latter first exclusive but later inclusive. In depth this zone included the Retrenched Line and the portion of the Middle Line in rear of it.

(*b*) The *North-west Section* (or zone) to the 16th Brigade under Major-General Delamain, or to the 30th Brigade under Major-General Sir C. Melliss, alternately. This zone included the remainder of the Front and Middle Lines. The brigade, not in occupation, formed the General Reserve in Kut itself.

(*c*) The *Kut, or River, Section* to the 18th Brigade under Brig.-General W. G. Hamilton. This section included Woolpress Village on the right bank (2 battalions), Kut itself, and the three miles of river bank from the town to the fort. The bank was guarded by pickets.

The 2nd Line was to be manned by the General Reserve in case of a threatened assault, being the final line of defence and covering all the artillery positions. Owing to the distance of the North-east Section from Kut, and its exposed position, it was difficult to arrange a relief for the 17th Brigade, so that brigade remained permanently in the front line and garrisoned the fort. Similarly the difficulty of relieving the battalions in Woolpress Village fixed the 18th Brigade in the Kut, or River, Section.

The vital portion of the defence was certainly the North-west Zone (D) where the front line was only 1,500 yards from Kut. The loss of the adjacent zone, the North-east, would have badly crippled the defence and particularly the artillery observation, since the observation post in the fort gave a base of over 3,000 yards to the other terminal in Kut town. But such a loss would not necessarily have been immediately fatal. On the other hand, the loss of the North-west Zone could hardly fail to result in the capture of many of our guns and of Kut town with all our supplies and munitions. It would also entail the isolation and surrender of the garrison of Woolpress Village. The river being impassable except for small detachments, no course would then remain open but a desperate attempt to cut a way out of the trap, northwards through the maze of Turkish trenches, without artillery or transport, in hand to hand conflict with superior numbers of the enemy.

General Townshend fully recognized the importance of the North-west Zone and arranged accordingly that his two best brigades, commanded by his most experienced officers, should relieve each other frequently in that zone, so that the troops in that part of the front line should always be as fresh as circumstances permitted. Every British gun could bring a devastating fire to bear against an assault on the north-west front, and machine-gun fire from Woolpress Village could enfilade it at effective ranges.

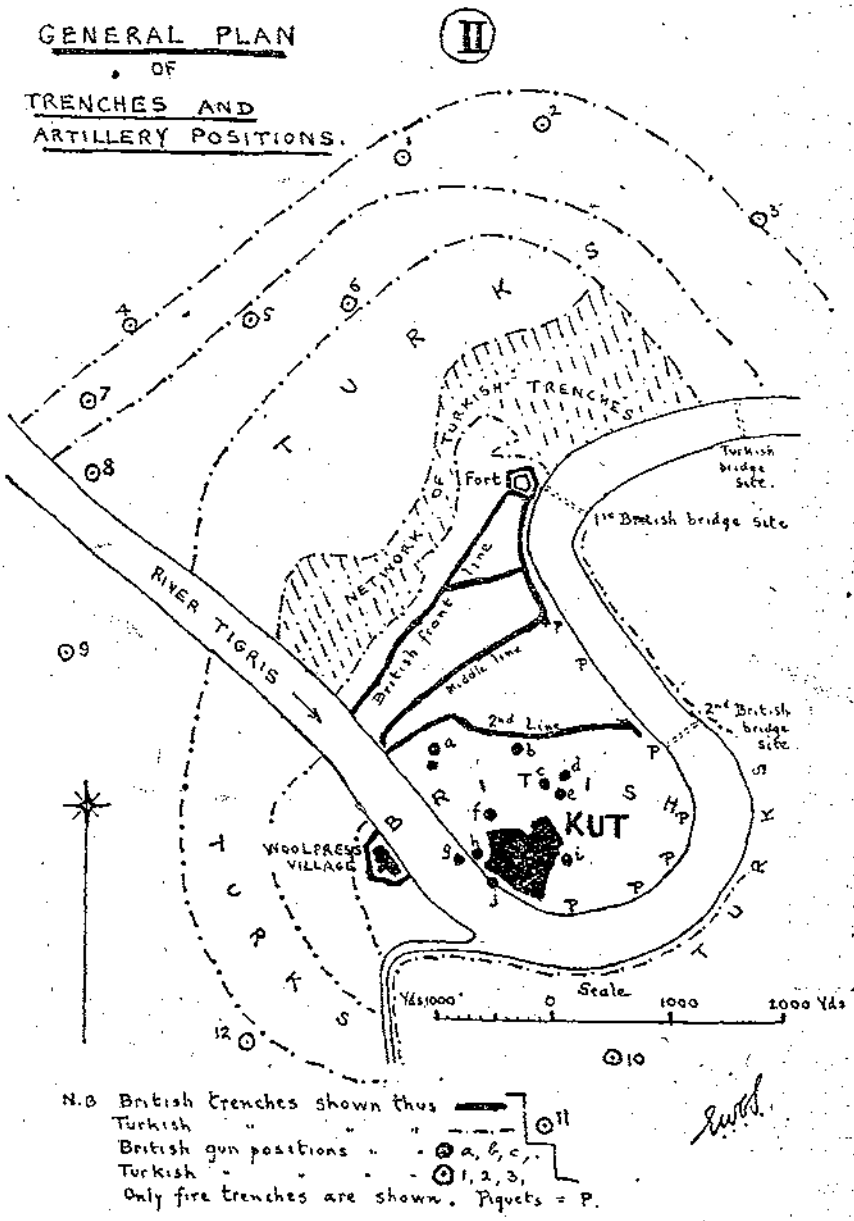
The garrison of Woolpress covered Kut from the west. The troops, however, were in a precarious position. They could not be strongly reinforced in case of violent assault, and they depended for their very existence on the survival of one steam tug (the *Sumana*) and a couple of motor boats which brought them food and ammunition across the river at night and were bombarded by artillery during the day. But the risk had to be accepted. If Woolpress had not been occupied, the enemy could have enfiladed our trenches and artillery positions, and Kut would have been uninhabitable under concentrated fire at close range. What, then, would have happened to our wounded, and to the 4,000 Arab women and children in the town whom the Turks would not allow to leave? Woolpress Village on the left flank, and the fort on the right, made the defence of the Kut peninsula possible.

Townshend's scheme of defence, as described in his book, was to

work on interior lines against the foe, throwing out a "Minimum Force" to the north-east, another to the north-west, and retaining under his control a central "Maximum," or Striking, Force, in or near Kut. His scheme was theoretically sound, but unfortunately the "Maximum Force," allowing for pickets, internal security and the garrison of Woolpress Village, was no larger than either of the two "Minimum" forces, and it could strike only to the north-east, north, or north-west, because the Tigris was an impassable obstacle. The truth is that, for a vigorous counter-offensive, the occupied area was too large for the British force, yet no smaller defensive position was available. If the "Maximum Force" delivered a counter stroke, the general direction of that attack would be known to the Turks, and the element of surprise would be lacking except as regards time; and even the time of attack was very difficult to conceal, as Kut was full of Arab spies who swam the river to carry news to their masters, the Turks. A reference to *Diagram* II will show, from the shape of the network of Turkish trenches opposing our front line, that the enemy expected a British attack north-eastwards from the Fort, though I should explain that both *Diagram* I and *Diagram* II show the systems of trenches as more or less completed later in the siege. Early in 1916 they were not quite so elaborate.

It has been said that Townshend should have cut his way out of Kut when hopes of early relief had vanished. Till the floods came in January he confidently expected an early relief. Up to that time he was threatened with an assault by large masses of Turks, close behind the force containing him, so he devoted his energies to strengthening his position in order to save his force from annihilation. When the floods came in January, the bulk of the Turkish troops moved downstream to Sannaiyat and Falahiyeh to resist the Relief Force, only a few thousands remaining in front of Kut on the heavily entrenched tracts showing above the swamps. Now supposing that the British could have forced a way along those fortified strips of ground, through line after line of wired trenches and under heavy artillery fire, obliged to abandon most of their guns owing to the mud and the shortage of horses, where were they to go? The only possible direction, which was of any use, was eastwards towards Sannaiyat and Falahiyeh, since the Tigris was impassable, *i.e.*, they would be advancing directly towards the main body of the Turkish Army, which was entrenched to resist the Relief Force. Again, supposing that they won through to Sannaiyat—a distance of 18 miles—could they join the Relief Force which was on the *right* bank and well downstream of that place? Such would seem to be some of the considerations which kept Townshend in the Kut peninsula, awaiting the chance of co-operating with the Relief Force when it came in sight of Kut, but unable to fight a way out to join it.

The British artillery in Kut was slightly more powerful than the


GENERAL PLAN
OF
TRENCHES AND
ARTILLERY POSITIONS.
II
TURKS
TURKISH TRENCHES
Fort
Turkish bridge site.
1st British bridge site
2nd British bridge site
NETWORK
Line
British front
Middle Line
2nd Line
RIVER TIGRIS
KUT
WOOLPRESS VILLAGE
Scale
Yds 1000 0 1000 2000 Yds
N.B British trenches shown thus
Turkish " " "
British gun positions " a, b, c,
Turkish " " " 1, 2, 3,
Only fire trenches are shown. Piquets = P.

Turkish artillery around it. *Diagram* II shows the various gun positions by letters or figures. Taking the British first, the following was the approximate distribution of guns :—

(*a*) 6 18-prs. (82nd Battery, R.F.A.)
1 13-pr. (anti-aircraft)
(*b*) 6 18-prs. (76th Battery, R.F.A.)
(*c*) 2 5-in. guns
(*d*) 6 18-prs. (63rd Battery, R.F.A.)
(*e*) 4 5-in. howitzers
(*f*) 2 4-in. guns
(*g*) 4 4·7-in. naval guns (afloat)
(*h*) 2 5-in. guns
(*i*) 4 15-prs.
(*j*) 1 18-pr.
1 13-pr.
2 12-prs. (naval)
1 3-pr. (naval)
} on the river front.

a total of 42 guns and howitzers.

The distribution of the Turkish artillery was :—

(1) 4 12-prs.
(2) 4 9-prs.
(3) 2 40-prs. (12 cm.)
(4) 2 large naval guns (doubtful calibre)
(5) 4 16-prs.
(6) 2 9-pr. howitzers
(7) 4 40-prs.
(8) 4 40-prs.
(9) 4 16-prs.
(10) 1 16-pr.
1 18-pr. (British)
(11) 2 30-pr. howitzers
(12) 1 30-pr. howitzer

Excluding an antiquated mortar of huge calibre, the enemy had thus about 35 guns and howitzers ; but, with the exception of the two large naval guns, which were soon out of action, and the 18-pr. which seldom fired, none of the Turkish artillery had high-explosive shells, and neither side had any really heavy artillery. Also, neither side used poison gas. Exposed to heavy shelling with high-explosives, Kut could not have lasted a month ; and, exposed to gas, the end would have come in a few days, as there were no gas masks. To give them their due, the Turks fought cleanly.

The struggle for Kut lay then between two forces evenly equipped with artillery, avoiding the use of gas, but with the British only using high-explosives. The Turks slightly outnumbered the British and

had large reinforcements close at hand, but the British were superior in training, discipline, fire-control and initiative. The Turks were poorly fed and had probably not too much ammunition, but they had no need to husband their ammunition very strictly. On the other hand, the British had ample food for two months, a large ammunition supply for their guns, and 800 rounds per rifle, but they dared not waste a single round. The Turks had excellent periscopes, a plentiful supply of bombs, and, after a couple of months, three German aeroplanes. The British had to manufacture their bombs and periscopes, and had no aeroplanes. And lastly, the Turks held the initiative and were in a seemingly friendly country, while the British were isolated, with their backs to the wall. It was a peculiar situation, and one difficult to describe in a few pages, but, having done so to the best of my ability, I will conclude with an account of the course of the siege which resulted from the decision to halt at Kut.

General Townshend's force marched into the Kut area on the 4th December, 1915, and the remnants of his shipping moored along the river bank. The Army Commander, General Sir John Nixon, had succeeded with great difficulty in making the voyage to Amarah, having been held up by Arab cavalry below Kut, so Townshend sent all his own shipping downstream as soon as possible after his arrival, keeping only one armed tug, a couple of motor boats, a few launches and barges, and his bridging train. He intended to use the bridge to maintain an active defence by transferring troops across the Tigris, when necessary, to operate against isolated bodies of the enemy. The bridging train did its part in enabling the 6th Cavalry Brigade to escape across the river near the fort on December 6th, before the Turkish investment was complete (see *Diagram* I), but the subsequent bridge higher up the river had to be destroyed after a determined attack by the enemy, a fate which was inevitable. The launches were lost with the bridge, and Townshend was thus practically isolated in the Kut bend on December 10th, and had only one tug, two motor boats, two small steel barges and about forty leaking *mahelas* (dhows) to enable him to send small parties of men across the Tigris. His intended active defence was then restricted to sorties northwards from his front line.

Every measure was taken to prepare Kut for defence. In addition to trenches and gun positions outside the town, internal communications were made or improved, lists of available supplies and stores were prepared and the supplies distributed, hostages were taken from the town Arabs as sureties for good behaviour, a Military Governor was appointed and police organized, mills for grinding grain were started, Arab labour gangs were marshalled, and buildings set apart for hospitals, offices, etc. In fact, the place hummed like a beehive, every man working against time. The Turks pitched their camp in the Shumran bend of the river, a few miles upstream, and busily unloaded stores and ammunition as they arrived, hurrying

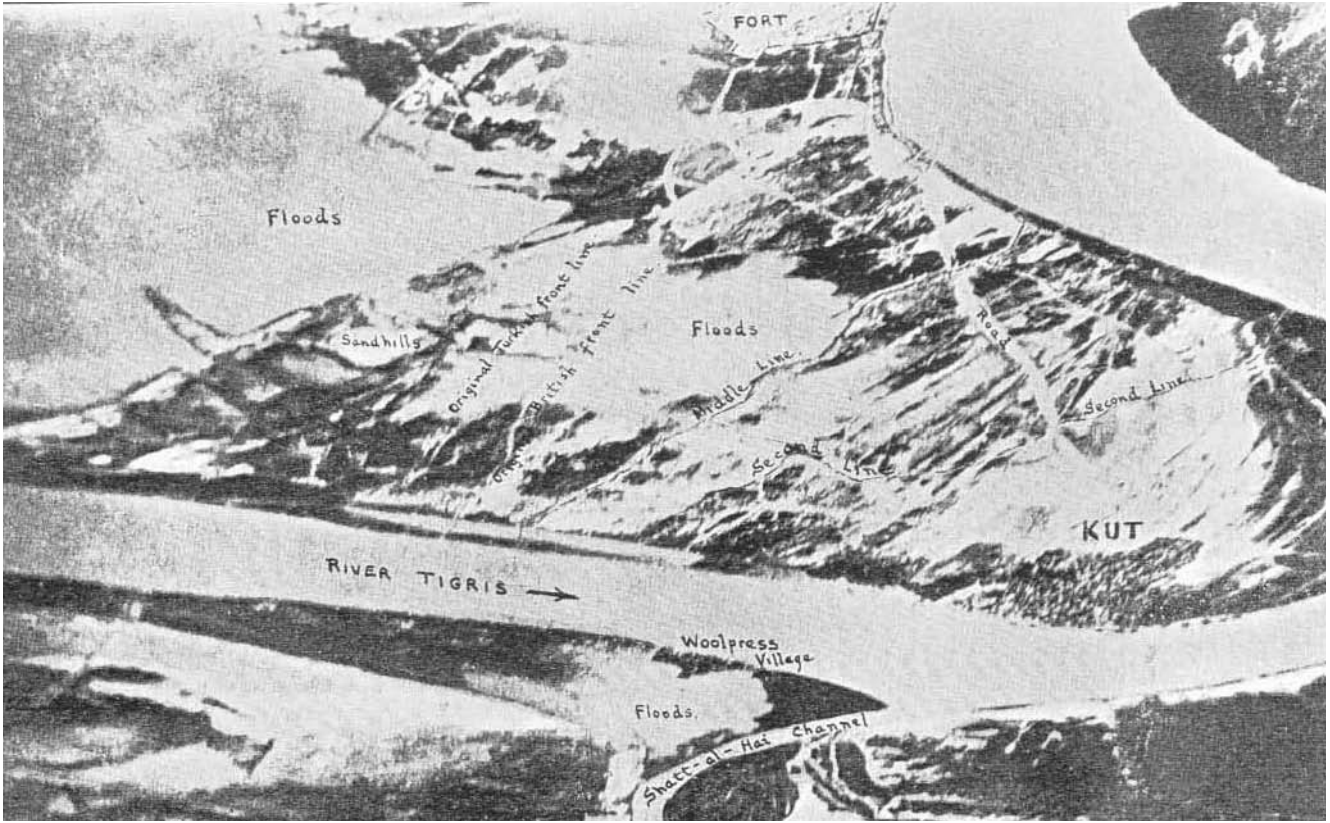
their troops off as quickly as possible to complete the cordon around the British and to dig as they had never dug before. Their guns were already in position by December 9th when they shelled the defended area severely, and, on the 10th, they threatened an attack on our unfinished front line, pouring in a heavy fire, but deterred from actual assault by accurate rifle and gun fire. The same thing happened on December 12th, and, during the next few days, the Turks pushed their trenches as close as possible to our North-west Section and to the fort. Then followed a lull while they prepared for the great attack on the fort on Christmas Eve. It was evident to all in Kut that a crisis was approaching, and they braced themselves for the ordeal.

During these early days of the siege, Kut was a paradise for the inventor, and, even to the end, the inventive genius had more than enough to think about. The Sappers and the R.A.F., in particular, out-Hiramed Mr. Maxim himself. There were no bombs, so the humble jam tin, gramophone needle, and detonator supplied the deficiency; there were no bomb guns, so old aeroplane cylinders, and even wooden battens and wire, replaced them; and later, as there were no anti-aircraft guns, a 13-pr. R.H.A. gun and carriage (minus wheels), suspended from a stake in a deep pit, found a new rôle, and was backed up by several machine-guns which were lashed to barrels pivoting on vertical spindles. Again, there were no periscopes, so the Arab ladies of Kut surrendered their mirrors, with weeping and wailing, for dissection by the prosaic Sapper. When coal was exhausted, the wooden timbers of the bazaar roofs fed the furnace of the tug *Sumana*; and, when wood itself was becoming scarce, the furnace was adapted to burn heavy oil in addition. One sad day a Turkish shell damaged the *Sumana's* main steam pipe. Immediately the Sappers turned out a passable fitting; and later, when another part was required, it was removed from a sister ship by the Relief Force downstream and dropped by aeroplane into the Kut area in response to a wireless demand. As there was no planking in Kut for bridging purposes, Arab front doors were collected and joined together with dogs made from verandah railings. And lastly, when the grindstone of a grain-crushing mill broke, a new granite stone was dropped 4,000 feet from an aeroplane and was spinning merrily in Kut within a few hours. I could write pages of description of the makeshifts employed during the siege, but space does not permit. Never did the Sapper lead a more thoughtful existence. The far-away look in his eyes, and the puckered brow, warned the world not to interfere with the mighty workings of the brain on which perhaps the cooking of to-morrow's breakfast might depend!

The long-expected attack on the fort came at last. Twenty guns opened fire on it at dawn on Christmas Eve, and a four hours' bombardment wrecked the walled defences of the north-eastern and eastern faces, driving the garrison to a stockade within the work itself. The Turks swarmed into the *débris*, and fought for hours with a

gallantry only exceeded by that of the defenders, but they were ultimately ejected with very heavy loss. When darkness fell they renewed the attack and again captured part of the fort, but were held up after a fierce struggle; and, with a last desperate and unsuccessful assault before dawn, they gave up the attempt and retired, leaving the ground around the ruined work a veritable shambles. Kut was saved, and was never again seriously threatened; yet it was only saved because the enemy made the fatal mistake of restricting his assault to one small portion of our defences. His attack was a determined one, but merely local, and he was afraid to incur the heavy losses of a simultaneous attack on the defences of the North-west Zone. Also, the preliminary bombardment of the fort gave due indication of his intentions, and destroyed the element of surprise. Von der Goltz, who had watched the attack on the fort, now returned to Baghdad, convinced that a policy of passive investment was preferable to active assault; and Khalil Pasha, who was left in command in front of Kut, conformed with his wishes by bombarding the place frequently and heavily, but attempting no attack. When the New Year came, the Turks had nearly 30,000 men and 83 guns around and below Kut. There were then 3 Turkish divisions at Shumran (11,500 bayonets with 41 guns), 3 divisions containing Kut (12,900 bayonets with 24 guns), 1 division at Es-Sin on the left bank (2,500 bayonets with 18 guns), and at Shaik Saad, 30 miles downstream, 4 battalions, some cavalry, and a camel corps. At the end of 1915, therefore, the enemy could easily have assaulted Kut with 24,000 men supported by 60 guns, whereas the actual attack on the fort on Christmas Eve was carried out by only 5,000 men supported by 20 guns, and of those 5,000 men barely 2,000 entered the fight, since the supports refused to leave their trenches. It was a pitiful example of the sacrifice of a few brave men by the adoption of a policy which was neither one thing nor the other—neither a sufficiently determined and general assault, nor a passive investment with a minimum force. However, the Turks had learned their lesson and now adopted the second alternative, while they hurried the bulk of their forces towards Sannaiyat and Shaik Saad to resist General Aylmer.

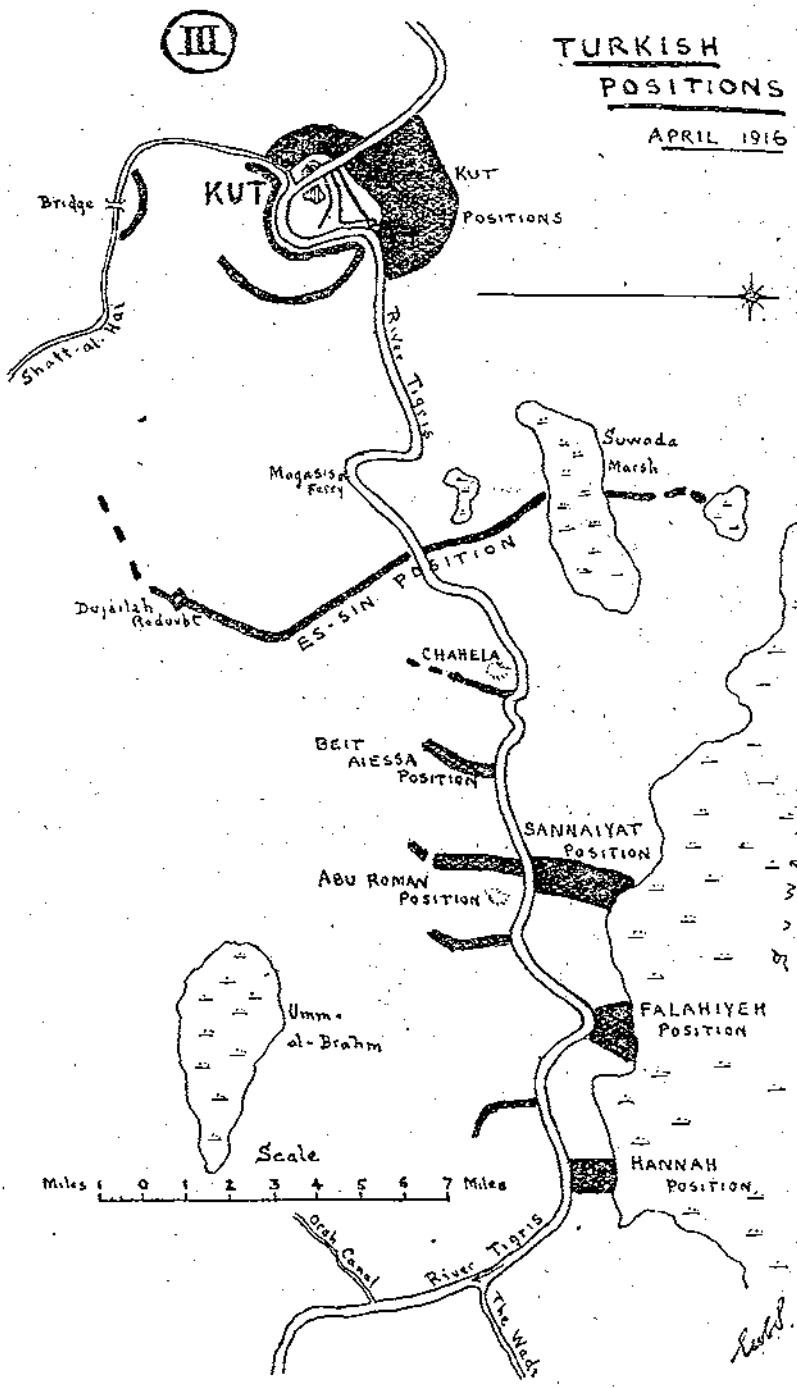
Hitherto the struggle had been between the British and the Turks, but another combatant now entered the fray—the Tigris. Swollen by the rains in Kurdistan and Persia, the river overflowed its banks on January 21st, assailing both British and Turks with equal ferocity; and the torrential rain, which had fallen around Kut since the 8th January, helped that assault by turning the whole country into a morass. The floods burst into our front line trenches in the North-west Zone, forcing the men to retire to the Middle Line. The Turks opposite to them, up to their necks in water, had to evacuate their own trenches a few hours later, and a sheet of water nearly a mile wide separated the combatants in that area on January 23rd. The floods extended to Redoubt B, but, thence to the fort, the origina



THE DEFENCE OF KUT-EL-AMARAH

front line could still be held. The photographic illustration, taken in April, 1916, from an aeroplane of the Relief Force shortly before the surrender, gives an idea of the extent of the flooded areas around Kut at that time, but they had then subsided considerably from the January level, *e.g.*, the swamped ground between the opposing lines near the Tigris in the North-west Zone appears as dry. From the middle of January every effort was made to save the Kut area from inundation, and large working parties of Arabs as well as troops were employed in throwing up miles of embankment to exclude the water. The Tigris soon became a greater immediate menace than the Turk, though the latter lurked behind the floods ready to take advantage of the work of his new and treacherous ally.

The progress of the Relief Force, in the operations undertaken to save Kut, was rather uncertain up to the middle of January. About that time, however, a wireless message arrived stating that General Aylmer's force, consisting of the 7th Meerut Division and other troops, had already attacked the Turks downstream of Shaik Saad and had captured their position, though they had lost 4,000 men in doing so. The heavy casualties in this battle, and the fact that the Turks had been sufficiently enterprising to occupy a position so far below Kut, gave food for serious reflection and caused some misgivings which we did our best to conceal. Another telegram stated that the 3rd Lahore Division from France "was nearing Basra," and we pondered on the significance of those last three words. However, we heard later that the Relief Force had turned the enemy out of a position east of the Wadi (upstream of Shaik Saad) on January 13th, and then that an assault on the Turkish trenches at Hannah (below Falahiyeh) had failed (see *Diagram* III). This attack took place in terrible weather over muddy ground on a very narrow front, so it is scarcely surprising that it met with little success. The Tigris and the adjacent marshes forced the British to attack frontally, and the space was so restricted that only a small number of men could advance to the assault. But in the operations ending with the failure at Hannah, the Relief Force had lost more than 8,000 men, and was thus brought to a standstill. This was a sad blow to the hopes of the Kut garrison, who now understood for the first time the quality and enterprise of the enemy, and the terrible natural obstacles created by the Tigris and the rain; so General Townshend, seeing that the rain, floods and bad news had damped the spirits of his men, issued a cheerful *communiqué* affirming his confident belief that Kut would be relieved during the first half of February. This pronouncement had the desired effect, and he continued to issue others from time to time throughout the siege; but the hopes raised by these *communiqués* were dashed to the ground each time, and the cheering news had less and less effect as the siege dragged its weary length, just as a drug loses its effect on a sick man. It seems to be a very open question whether the maintenance of morale by the issue of optimistic


III
TURKISH POSITIONS
APRIL 1916
KUT
KUT POSITIONS
Bridge
Shatt-al-Hai
River Tigris
Magasis Ferry
Suwada Marsh
Dujailah Redoubt
ES-SIN POSITION
CHAHELA
BEIT AIESSA POSITION
SANNAIYAT POSITION
ABU ROMAN POSITION
Umm-al-Brahm
FALAHIYEH POSITION
HANNAH POSITION
Scale
Miles 0 1 2 3 4 5 6 7 Miles
Orah Canal
River Tigris
The Wadi

reviews of the situation is advisable when that situation is obviously very grave. On the other hand, the policy of withholding information may lead to pessimistic conjectures which are bad for morale. Perhaps a bald statement of the true situation, coupled with *hopes* of ultimate victory, may be best.

The check at Hannah, which could only mean a much prolonged siege, concentrated the attention of the garrison on the matter of supplies. At the end of January, 1916, there began to be a scarcity of flour in Kut, though large amounts had been discovered in the town. Having already eaten most of the oxen of the Heavy Battery gun teams, the troops were then issued with horseflesh, but many of the Indians refused to touch it at first and consequently suffered much from hunger and weakness. Each British soldier, at that time, got 12 oz. of bread and 2 oz. of jam or butter daily, and, sugar being finished, was issued with 4 oz. of dates as a substitute. It was not till early in March that food became really scarce; the date supply was then exhausted, the ration of tea ceased, and even the jam ration was reduced to a mere taste and soon ended. After the failure of General Aylmer's attack on the 8th March, the bread ration was reduced to 10 oz., at the end of March to 8 oz., on April 12th to 6 oz., and on April 22nd to 4 oz.—a starvation ration indeed. Thus, to the bitterness of hope deferred, were added the gradually increasing pangs of hunger, and each reverse of the Relief Force, which was also on reduced rations, meant a further tightening of belts in Kut. The rations of the Indian troops dwindled equally with those of the British, yet, to the credit of all, each reduction was accepted as inevitable and was even made occasionally the subject of jest. There was always plenty of horseflesh, though it failed lamentably to satisfy bodies craving for cereals and sugar. Horses consume a vast amount of grain, and all the available grain was wanted for human consumption; therefore, not only were the horses slaughtered daily to provide meat rations for the troops, but four hundred were destroyed and buried, one day in March, merely to reduce the consumption of grain, and thus the bulk of our artillery had to be rendered immobile in order that the men might survive. Personally I found horseflesh rather sickly in flavour and preferred mule. *Mule's tongue in aspic* once graced the table of the R.E. Mess and was greatly appreciated! Roast donkey was said to be unpalatable, and none reached our mess, but I had the offer once of some camel stew made by my men and approached it with curiosity not unmixed with doubt—I left it hurriedly, and with no doubt at all. Towards the end of the siege, desperate attempts were made with three or four aeroplanes to provision Kut by dropping sacks of flour within the defended area, but, as the result of 11 days' flying, the machines only dropped enough flour to give a 4 oz. bread ration to the troops alone for four days, allowing nothing for the Arab population. The effort was therefore a failure, and hardly influenced the duration of the siege. As a

forlorn hope a crew of volunteers in the river steamer *Julnar* attempted to run the gauntlet of the Turkish positions on April 25th with 270 tons of selected provisions for the Relief Force. Sad to relate, the ship was disabled and captured at Magasis, within sight of Kut, and thus it was decreed by fate that the garrison should perish by starvation, or surrender to the Turks and accept a destiny hardly less cruel.

The weather improved in the middle of February, and the spirits of the troops rose in consequence. The distant thunder of Aylmer's guns could be heard distinctly. On February 13th the first hostile aeroplane dropped into Kut several 30-lb. British bombs captured during the retreat from Ctesiphon, and arrangements were made at once to provide anti-aircraft defence as I have already related. During the next few weeks, the Turks bombed Kut frequently, sometimes with three aeroplanes, though they did comparatively little damage. Nevertheless, the effect on the Arab population was bad, and we were glad when the aeroplanes found more urgent work at Sannaiyat, Falahiyeh and Shaik Saad. The energies of the garrison were devoted during February to elaborate preparations for co-operation with the Relief Force when it had broken through the Turkish positions and reached the Tigris near Kut. A sympathetic wireless message arrived from His Majesty the King which put new heart into the men, and some newspapers, dropped from aeroplanes, showed that the predicament of Townshend's force was fully understood at last in England. The hospitals in Kut were overcrowded with sick as well as wounded, for scurvy and other diseases had appeared and claimed new victims every day from among the more debilitated. But those who were capable of work laboured with renewed vigour, and the preparations for attacking the enemy, when General Aylmer arrived on the scene, were soon complete.

General Townshend's alternative schemes for co-operation with the Relief Force, when it approached, were as follows :—

(*a*) To attack the Turkish camp on the left bank at Shumran upstream of Kut.

(*b*) To attack the Turks when they were retiring past Kut on the left bank after they had evacuated the Hannah position owing to the operations of the Relief Force.

(*c*) To evacuate Kut, crossing to the right bank with guns, ammunition, supplies, sick and wounded, while the Relief Force attacked and held the enemy.

(*d*) To reinforce the garrison of Woolpress Village on the right bank, and then to launch an attack from that village to facilitate the crossing of the Shatt-al-Hai Channel by the Relief Force.

(*e*) To cross the Tigris with a "Maximum Force" to co-operate with General Aylmer, while still holding Kut with a "Minimum Force."

None of these schemes, however, could be put into action, because General Aylmer never came within sight, and I do not believe that Schemes (*c*), (*d*) and (*e*) were possible when he attacked in March, owing to the lack of boats in sufficiently good condition to transport large numbers of troops across the river. The schemes involved much work for the Sappers. The preparation of bridges to enable our guns to cross trenches, and the manufacture of trestles and decking for bridging the Shatt-al-Hai Channel, kept the men busy from dawn till sunset. An elaborate floating mine was also contrived with the idea of blowing up a Turkish floating bridge far down that channel (see *Diagram* III).

On February 22nd the whole garrison stood to arms throughout the day. It was the occasion of a surprise bombardment of the Turks in the Hannah position, whereby General Aylmer hoped that they might be induced to vacate their trenches and retire up the left bank. The enemy, at this time, had 10,000 men in that position, 8,000 at Es-Sin, and another 8,000 around Kut. General Townshend was requested by wireless to attack the Turks when they retired past Kut, *i.e.*, to put into operation his Scheme (*b*); but they, with their usual tenacity, refused to budge from their trenches at Hannah, and indeed, the British artillery bombardment, unsupported by infantry attack, was not such as to force seasoned troops to abandon their positions. Surprise bombardments of the same kind were tried on two or three occasions subsequently, but always without result. In a way they served to encourage the garrison in Kut, just as the sound of the picks of a rescue party may encourage entombed miners, though a reaction set in when the roar of the guns died away without news of any assault. Sweepstakes were arranged on the date on which the first of Aylmer's ships would pass the fort, and excitement grew daily as the time approached for the great attempt. At last it came, and on March 8th we stood to arms again throughout the day while our fate hung in the balance. We had launched the floating mine during the previous night, though it failed to reach its objective, and our guns fired on every target, regardless of ammunition, while daylight lasted. Every man knew his job and longed to do it, but was obliged instead to sit powerless in his trench, consumed with anxiety which increased as the hours wore on. From the house-tops in Kut we could see the British shrapnel bursting in salvos along the whole length of the Es-Sin position, only six miles away, and the roar of the bombardment was incessant. Turkish batteries galloped hither and thither on our side of the clouds of smoke, and columns of infantry hurried to the fight across the dusty plains. For several hours the din continued, became intense at sunset, died away during the night, and burst out again on March 9th, but not one soldier of the Relief Force did we see. Then there was silence, the troops returned to their billets, and, on the following day, we heard of the long night march from the Wadi, the bombard-

ment of the empty Dujailah Redoubt at dawn, the failure of the infantry attacks on that redoubt when manned, and the precarious retreat to the Wadi. The blow was almost paralysing. Rain fell again in torrents, rations were reduced, and there were grim faces in Kut. In the minds of one and all was the well-night incredible fact that *Aylmer's attack had failed* and that no relief could be expected till many weeks of starvation had been endured.

In some of the officers' messes, the monotonous diet of horseflesh was much relieved for a time by the addition of roast starling when the few sportsmen who had shot-guns could sally forth into the palm groves outside the town. Starlings and sparrows clustered in hundreds on the palm fronds, but, as ammunition was very precious, it was no time for sporting shots at flying birds. I remember seeing a keen *shikari* waiting patiently under a branch till it was crowded from end to end with chirping birds. Slowly, slowly, he raised his gun, and with careful aim let fly so as to enfilade the line. A shower of starlings fell to earth, and, rather shamefacedly he put away his gun while his orderlies collected the dead and dying. He remarked to me that he knew it wasn't sport, but that he was hungry and there were many in his mess. I was hungry, too—painfully hungry—and the prospect of another horseflesh supper was nauseating; so, when he had gone, I hunted around on the chance of picking up a sparrow or two, or perhaps even a stray starling; but the Arabs had already searched the ground and there was not a feather to be seen, so I returned empty-handed through the evil-smelling streets.

Four days after the failure at the Dujailah Redoubt, General Gorringe, previously Chief of Staff, succeeded General Aylmer in command of the Relief Force. He proceeded at once to investigate the possibility of another attempt up the right bank, but decided that, as the country on that side could be flooded at will by the enemy, an advance up the left bank was more likely to succeed, though it would necessitate the deliberate frontal assault of position after position held in strength by the enemy. Accordingly he prepared to renew the attack on the Turkish position at Hannah on the left bank, where the 7th (Meerut) Division had already sapped up close to the hostile trenches. The 3rd (Lahore) Division was on the right bank, and General Gorringe brought up the 13th British Division to relieve the 7th Division and assault the Turkish position. He informed Townshend that the Kut force was "the rock on which he hoped to split the Turkish forces," and urged him to bombard the enemy's ferry at Magasis in the Es-Sin position and to contain the enemy on the left bank near Kut in the final stages of the operations, if successful. It appeared, therefore, that the open warfare of early March was to give place to a deliberate advance with limited objectives—in fact, to the type of warfare elaborated in France and Belgium. The dispositions of the enemy, and the condition of the ground, necessitated this change, but it was very doubtful if Kut could be

reached by these methods before the garrison was forced to surrender from starvation.

By the middle of March, the network of Turkish redoubts, trenches and wire around us was practically complete, and the enemy still further reduced his containing force. Khalil Pasha affirmed, after the surrender, that at one time he had only 3,000 men in the trenches before Kut, and, considering the state of the ground and the strength of the Turkish positions, he probably spoke the truth. The river level was rising again. More and more ground was becoming flooded. The enemy's artillery and aeroplanes increased their activity as his troops moved downstream, and, from March 18th to March 23rd, there were heavy bombardments and aeroplane raids at intervals. But the Tigris then became so threatening that hostilities ceased, and both combatants fought the water instead. The flood culminated on March 26th, when Redoubts A and B were inundated and most of our trenches were impassable, as there were no "duck-boards." Kut town and the adjacent ground, protected by continuous embankments three feet high, were actually below water level for several days, and only the most constant inspection and repair of the earthwork saved us from disaster. The siege may be said to have ended with the advent of the great flood of March, 1916. The fate of the garrison was then sealed, though no one would have admitted it, whatever his misgivings. Kut then became merely a backwater of the torrent in Mesopotamia—a prize for the winner in the furious struggle below Sannaiyat.

General Gorringe, urged to premature action by the desperate circumstances, seized the opportunity of a break in the deluge of rain which had fallen early in April to launch his attack against the Hannah position. He wired at 8.0 a.m. on April 5th to say that he had captured five lines of trenches, and then there was silence. It appeared later that he captured the Abu Roman position on the right bank opposite Sannaiyat on April 6th, then the Falahiyeh position on the left bank upstream of Hannah, and entrenched close to the Sannaiyat position on April 8th (see *Diagram* III). But when, at dawn the next day, he attempted a surprise assault on that position, his troops were discovered as they staggered through the morass and were mown down by concentrated machine-gun fire. The attack failed with terrible loss, and the Relief Force was obliged to pause to receive reinforcements, which brought its total strength to 29,000 bayonets and 133 guns; but, meanwhile, the 3rd Division managed to take the Beit Aiessa position on the right bank, whence enfilade, and even reverse, fire, could be directed on the Sannaiyat trenches across the river. The 13th British Division then moved forward towards Chahela, threatening the left of the enemy around Beit Aiessa and overlooking his communication trenches on the other bank leading to the Sannaiyat position. It was altogether a very curious situation, the British on the right bank of the Tigris being almost in rear of the

Turks grimly holding the Sannaiyat position on the left bank. General Gorringe made his last desperate effort on April 22nd, when his assault on the Sannaiyat position was again repulsed with very heavy loss. With that disaster, our last hope of relief vanished, though the gallant attempt to send food to Kut in the steamer *Julnar* on the 25th April might possibly have enabled the garrison to hold out for a few more weeks if it had succeeded; but I do not believe that, during that period, the Relief Force could have reached Kut, an opinion formed after a study of the resistance met by General Maude only a few months later.

There is little to write of the latter days of the siege itself. The usual routine continued, as far as the waning strength of the men would admit. The weather got warmer, and the stench of the streets and the bites of myriads of sandflies added new discomforts to the pangs of increasing hunger. The Arabs gave up hope and tried to leave the town. Every household was hard at work making rafts of tins on which to float down the river, and each night the rafts were launched from the river front; but the men, women and children on them were shot down by Turkish machine-guns below the fort as an example to deter the remainder. Hardly a soul escaped alive; yet, night by night, the Arabs went to their doom rather than trust to Turkish mercy after the surrender. On April 27th, a few days after the death or murder of Von der Goltz at Baghdad, an armistice was arranged at Kut. Two days later, General Townshend surrendered, and the Turks marched in past the fort.

Khalil Pasha did not capture a single British gun when his men entered Kut. Every gun and howitzer had been destroyed with guncotton, the motor boats sunk, the wireless apparatus burnt, the ammunition thrown into the river, and most of the rifles rendered useless. As for supplies, he was welcome to the sacks of ginger which revetted one of our paths, for that was about all we gave him! The 6th Indian Division and 30th Brigade had held out for 143 days—23 days longer than Ladysmith—and they were finally overwhelmed, not by the Turk, but by starvation and flood. They were never defeated in battle. The capture of Kut-el-Amarah was the last striking success achieved by Turkish arms during the Great War, and it was amply avenged by General Maude in 1917 and General Allenby in 1918. Its lessons are many—the danger of allowing investment under any circumstances, the risk of underestimating an enemy, the difficulties of calculating available supplies in a hostile land, and the disastrous effect of rain and floods—but, whatever errors may have been committed, whatever losses incurred, the defence of Kut and the valiant attempts of the Relief Force showed the grit and courage of the British soldier and his Indian comrade in arms, and thus they form together a page in the history of the Empire of which England need never be ashamed.

*THE REORGANIZATION OF THE ENGINEERING TROOPS OF A CANADIAN DIVISION—GREAT WAR, 1914–18.**

By MAJOR (Bt. COLONEL) H. F. H. HERTZBERG, C.M.G., D.S.O., M.C., *p.s.c.*, R.C.E.

(*Written in March, 1920.*)

PRIOR to the reorganization, which it is proposed to describe in this article, the engineering troops of a Canadian division in the field were as laid down in War Establishments for the Britannic Forces and consisted of the following units :—

(1) A Headquarters, Divisional Engineers.
4 officers, 20 other ranks, 15 horses.
(2) Three Field Companies (each).
6 officers, 210 other ranks, 73 horses, transport including pontoon equipment for 75 feet of medium bridge.
(3) A Pioneer Battalion.
30 officers, 1,000 other ranks, 54 horses.

A total force of 58 officers, 1,650 other ranks, and 303 horses.

After the reorganization each Canadian division was allotted an engineer brigade comprising :—

(1) A Brigade Headquarters.
4 officers, 22 other ranks, 9 horses.
(2) A Bridging Transport Unit.
3 officers, 66 other ranks, 73 horses, transport included pontoon equipment for 225 feet of medium bridge.
(3) Three Battalions (each).
37 officers, 969 other ranks, 148 horses, 8 lorries.

A total of 118 officers, 2,995 other ranks, 526 horses, and 24 lorries, besides one motor car, 3 box cars and other vehicles.

The decision to make this drastic change in this arm of the Service was finally taken at a very critical moment in the campaign—probably at the turning point of the War. The enemy offensive of the spring of 1918 had been to all appearances stopped ; but the Canadian Corps, although held in G.H.Q. reserve ready to be thrown into the most threatened part of the line should the enemy again attack, was, at the same time, undergoing a process of intensive

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training in open warfare preparatory to the Allies' offensive which commenced in July, 1918. To completely wipe out the old system, which had been functioning for some four years and in which officers and men were more or less experienced and trained, and to inaugurate an entirely new and untried organization at such a time was a big decision to take. The difficulties surrounding it and the risks which it entailed were only too well appreciated. On the other hand the advantages to be gained, if success was obtained, were many and important. The pros and cons were consequently very carefully considered, with the result that early in May, 1918, the reorganization was ordered to be proceeded with at once. Establishments were prepared, approved and issued; the new units were formed on paper and, finally, the three field companies and pioneer battalion in the division of which the writer was C.R.E. at the time, were, on 7th June, 1918, marched on parade, disbanded, formed into the new units and marched off the parade as a brigade of engineers.

The primary reason for this reorganization may be stated, generally, in a sentence. A self-contained engineering organization was required that would be capable of not only supervision, as heretofore, but also of carrying out the actual construction of all engineering work. The necessity for such an organization became more and more pronounced as the character of the fighting changed; more permanent and heavier defence works of all kinds were developed, deep dug-outs, subways, deep machine-gun emplacements, protection from air craft, defences in great depth, enormously increased tonnage of ammunition for guns and trench mortars entailing improved communications and increased transportation facilities such as tramlines and better roads; all of which caused a corresponding increase in the duties and work of engineers to such an extent that the old system of sapper supervision and infantry labour was found utterly inadequate to cope with the new requirements.

It is proposed to deal with the details of the question as concisely as possible, under three main headings:—

(A) Defects in the old organization.
(B) Difficulties encountered in making the change.
(C) Results, after actual trial, of the new formation.

(A)—Defects in the Old Organization.

The usual custom was for a field company to be allotted to an infantry brigade area, to be responsible for the work in that area both to the C.R.E. and to the infantry brigadier, thereby involving all the evils and confusion of dual control. Theoretically, the field company reported direct to the C.R.E. and was not under the orders of the brigadier but only attached to him to supervise the

work in his brigade area; but, actually, the field company was in much closer touch in every way with the brigade than with the C.R.E.; it moved usually under brigade orders, received rations, etc., through the brigade supply officer, and was generally looked upon by the brigadier as one of his own units; the C.R.E., unless a very strong personality in the division and an exceptionally energetic man, was regarded too often as a far-away sort of person at division headquarters, to whom work reports were sent. The C.R.E., although nominally responsible for all defence works to the divisional commander, had usually the greatest difficulty in carrying out work in accordance with the divisional scheme, because each brigadier in his own sector of the line had his own special ideas on what work was required and how it should be done; which, after all, was natural enough in view of the fact that he was held responsible for the defence of that sector and his brigade was finding the labour to carry out the work. Confusion, lack of efficiency and waste of labour and material were the obvious results. For instance, one brigadier holds a section for eight days and commences work which he considers necessary, he is relieved by another brigadier at the end of that time who holds different opinions, the result being new work is commenced and the previous tour's work is left incomplete and of little or no value. The cause of this trouble was due mainly to the fact that field companies were too closely affiliated to brigades and that, as all labour was usually supplied by the brigade, the brigadier naturally felt that he should say how, when and where it should be used. Consequently it was a very difficult thing, indeed, to maintain the proper continuity of work during brigade reliefs.

The second and perhaps the greatest evil of the old system was the infantry working party—something despised and loathed by the infantry and, incidentally, not over loved by the sapper. The infantry claimed they came to war to fight, not to dig, and they did just as little of the latter as they possibly could, regarding it rather in the light of a degrading fatigue. The officer disliked it just as heartily as the man. He usually showed little or no interest in the work on hand and he felt no responsibility for its completion, apparently being under the impression that his duties ceased when his party was turned over to the engineer representative at the pre-arranged meeting point if, indeed, he had been so fortunate as to find it at anywhere near the appointed time; and that his services would not again be required until the time arrived to break off and take his party back to their lines. When, as a matter of fact, the duties of the engineers, properly speaking, consisted in laying out the work, allotting tasks and assisting in explaining what was required; the infantry officer was then responsible for his men doing the required amount of work and not leaving the job until their tasks had been completed satisfactorily; the motto being

"engineers responsible for *quality* and infantry for *quantity*." Also, the engineers sometimes failed to supply tools or materials, or they arrived late and the infantry, who had perhaps been in the trenches all day, were forced to sit around and wait in rain and bad weather and probably under fire; again, the engineer officer was late or did not know his job, and consequently delay occurred and unnecessary work was done. These and many other incidents, too numerous to mention here, tended materially to interfere with the efficient carrying out of the work in hand. One of the greatest objections to infantry working parties must be noted before leaving the subject, namely, that it was rarely, if ever, possible to keep the same men, or even the same unit, on any one piece of work until its completion; attempts were continually made to turn over one trench or one piece of work to some definite company or platoon, to be its own particular little job to do as well as possible and as quickly as possible and, as their work was well or poorly done, so they would deserve praise or censure. If this could have been arranged the men would have become familiar with the work, guides would not have been required and parties would not have so frequently gone astray and missed the meeting places, etc.; and some interest and keenness might, perhaps, have been created in the work.

The third important defect in the field company organization had to do with the R.E. park, workshops and the transporting of material. No establishment whatever was provided for personnel to operate divisional parks and workshops and, as these were, of course, essential, the necessary men had to be attached from field companies and infantry brigades, which was decidedly objectionable from the standpoint of those units. As regards transport for engineer material, there was none; field companies had only sufficient transport for their own permanent equipment; so that all sorts and conditions of wagons were used for this purpose; pontoon and trestle equipment of field companies was, when possible, off-loaded and parked and the wagons used for carrying timber and every imaginable class of R.E. material from the R.E. parks to forward dumps. G.S. wagons and forage carts were also obtained from infantry brigades for work only in that brigade's area. This transport was not sufficient and finally lorries were obtained daily from the corps when they would be spared, which was not always by any means, and the whole system of transporting engineering material was most unsatisfactory.

Another objection to the old organization was the great difficulty in relieving field companies and bringing them out of the line for purposes of training, refitting and rest. This was found, with very few exceptions, to be impossible; the amount of work was so large, the personnel to do it so limited, that field companies were frequently

left on front line work for months, night in and night out with no relief whatever, except what could be arranged by sections in the unit itself. Apart from the hardship to officers and men, the lack of training was seriously felt, especially as drafts came from England containing men who could hardly be termed soldiers, and certainly not trained sappers, capable of supervising the rather complicated construction of, say, a deep dug-out or other work requiring technical knowledge.

And now a word about the pioneers who were very welcome when they finally arrived. A battalion was assigned to each division, reporting to the C.R.E. as regards work, but administered by the division—again the dual control and all the troubles connected with it. However, the pioneers proved very useful indeed. The writer found they worked most satisfactorily when given certain definite work to do—a long communication trench, a redoubt, a scheme of wiring, etc.—where it was possible to keep a company on the same job until it was completed so that no labour or material was wasted due to that lack of continuity and change of personnel, which, with the infantry working parties, was so prevalent. The pioneers, however, were not trained sappers, nor were their officers, with few exceptions, engineers; so that usually engineer supervision was still required.

(B)—Difficulties Encountered in Making the Change.

For the formation of each engineer brigade the following units were available in each division:—

(1) H.Q. Divisional Engineers,
(2) Three Field Companies,
(3) One Pioneer Battalion,

while the technically trained and experienced tunnelling personnel required in each brigade were to be found from the tunnelling companies heretofore employed directly under the Chief Engineer of the corps. The brigades were then to be completed and brought up to strength as far as possible in officers and men by drawing on the training depôt in France and the reserve depôt in England.

The existing headquarters, divisional engineers, formed the foundation for the headquarters of the brigade. The three field companies formed respectively the nuclei of the three battalions. The headquarters and three of the four sections of each field company serving as a basis for the headquarters and three of the four companies of each battalion; the fourth section of each field company being equally divided into three parts, each part being allotted to one of the other three sections; the intention being to form the fourth company of each battalion from the tunnellers, which was duly carried out some two weeks after the brigades came into existence.

The engineers and tunnellers therefore, as above described, were equally distributed in each battalion and formed the technically trained portion of it. The pioneer battalion was then divided into three equal parts and one part allotted to each battalion as the untrained or labour portion; the remaining deficiencies in the strength of each battalion were then made up from the depôts as far as men were available. Some officers and other ranks of the infantry with engineer training and experience were interviewed with a view to their transferring to the sappers, but very few men were obtained in this way. As regards transport; the field company and pioneer transport, less bridging equipment, was divided equally among the three battalions, while the pontoon and trestle wagons with equipment and horses were taken from the field companies and formed the divisional bridging transport unit.

There were numerous objections to, and difficulties encountered in, the process of reorganization as above outlined. In the first place, there was by no means a sufficiency of officers and men to complete the units as authorized by establishment and, at first, a battalion totalled about 17 officers and 650 other ranks; this was, however, gradually increased until a battalion reached approximately 30 officers and 800 other ranks. The same remarks, as to proportion and gradual increase, may be made regarding the transport, including horses, vehicles and mechanical transport. The delay in supplying the requisite additional transport was largely due to the fact that the British Government was at that time supplying transport for the new American divisions to a very considerable extent.

In the second place, very strong representation was made by the pioneers against the breaking up of their units with the inevitable loss of their identity, etc., and this was only finally agreed to on the understanding that officers and N.C.O.'s of the pioneers should be absorbed by the sappers with their existing rank and seniority. This, in a way, was only fair and equitable from the pioneers' standpoint; nevertheless, the arrangement led to serious difficulty later on, and, naturally, gave rise to strong objections on the part of the junior engineer officers and N.C.O.'s who, in spite of the fact that they were trained and experienced engineers, were forced to serve under men who knew very little about such work. Also, in many cases, officers and men from the pioneers, through no fault of their's but simply due to lack of training and experience, were called upon to perform duties and assume responsibilities which, in all fairness to themselves and for the general good of the Service, they should not have been called upon to undertake.

Another criticism, and a very fair and reasonable one, was encountered from certain quarters representing the more senior Royal Engineer officer; and this officer had strong arguments in his favour, supported by his own long service and extended experience

as well as by the wonderful record and glorious traditions of the Corps of Royal Engineers. He disliked very much the idea of his technically trained sappers being contained in the same unit with his unskilled labour; it had too much the appearance of a labour battalion. He considered further, and his point is well taken, that the percentage of the sappers to the infantry in a division would be too high. He also considered the new battalion too large a unit to employ on some special detached duty, such as with an infantry brigade on advanced or rear guard; this objection is not so well taken because the battalion was so organized that each company, or even section, was a self-contained unit with its own transport, including tool cart (bridging equipment as required could be attached from the bridging transport unit), and was therefore just as easily detached as the old field company.

There were, of course, in addition to those already quoted, other objections, both varied and numerous, which cannot be included here. Perhaps the most important of all is that which has been referred to in a previous paragraph, namely, the very critical stage in the operations of the campaign in which the change was made, and not the least danger in this connection was the tremendous risk taken in breaking up the organization of the tunnelling companies. It was because of this danger that all tunnellers were kept together in "D" Company of each battalion so that, if the new system had failed as regards tunnelling operations, it was a comparatively simple matter to reform the old tunnelling companies with the same personnel as before without delay and without upsetting, to any appreciable degree, the organization of the new battalions.

(C)—Results after Actual Trial of the New Formation.

The new organization received its first test in August, 1918, in the Battle of Amiens. The results are known. They left no doubt as to the success of the new machine and, through the following hundred days' fighting which terminated in the capture of Mons, its efficiency and value were proved beyond all question. It was found that the long-desired self-contained engineering organization had been obtained. Infantry working parties were things of the past except for hasty consolidation, maintenance of their own front line system and other similar work which required no technical supervision. Work was accomplished in less than half the time required under the old system, because divisional areas were divided so that an engineer battalion had charge of each, remaining in that area directly under the orders of the C.R.E. irrespective of reliefs of infantry brigades; hence continuity of the work was maintained—the same men on the same job until it was finished. In the advance on Cambrai and Mons, all work in connection with roads and bridging

was under the C.R.E. and carried out in accordance with a pre-arranged scheme, usually prepared by the Chief Engineer at the corps, so that absolute co-ordination of the work resulted. When required, each infantry brigadier was given a company from an engineer battalion to assist him in any way he wished, this company working directly under his orders, so that he was just as well off under the new system as when he had an affiliated field company under the old system.

The creation of the bridging transport unit was particularly suitable to the new conditions. Under the old system all the bridging equipment of the division was distributed equally to the three field companies, with the result that the company which happened to be employed on bridging operation usually found its 75 feet of medium bridge insufficient for its requirements. On the other hand the remaining two companies, probably detailed for work on defences and roads, had no use for this equipment, which was consequently lying idle when it was urgently required by the first company to complete their bridges. This difficulty disappeared with the advent of the bridging transport unit. This unit contained all the bridging equipment of the division and was so organized that the pontoons or trestles required for any operation might be attached temporarily to the battalion in charge of that work. Again, when the division was holding a front in which no bridging was required, its B.T.U. could be detached intact and placed at the disposal of another division where operations demanding such equipment were in progress.

Another function of the B.T.U. was to form the divisional R.E. park and workshop, its establishment in personnel providing the various trades necessary for this purpose. The pontoon and trestle wagons of this unit were available as transport for material by off-loading their equipment when it was not required.

At corps headquarters the new engineer M.T. company formed a pool of lorries under the direct orders of the Chief Engineer. This company was so organized that a section could be detached and placed under the orders of the C.R.E. of a division when advisable. In this way the great problem of transporting engineer material under the old system was solved; it was no longer necessary to beg, borrow or steal lorries from the M.T. column or horse transport from infantry brigades.

An important departure from the usual method of carrying out engineer services and controlling engineer personnel was made during the advance from Arras to Mons. This new method had been tried with success in the Somme operations under the old field company system; the adaptability of the new organization was such that even greater success was attained in employing this new method in the advance above mentioned. The departure referred to con-

sisted in all divisional engineers being pooled under the direct executive command of the Chief Engineer Canadian Corps, who became the G.O.C. Canadian Engineers. The corps area was then divided into four more or less equal parts, two forward (A and B) and two rear (C and D), conforming to the four divisions in the corps. A brigade of engineers was then made responsible for each area irrespective of what division happened to be holding it. A and B Brigades in the two forward areas being employed on hasty repairs to roads and bridges, reconnaissance and preparation of crossings for infantry, guns and light transport; they advanced as the line moved forward until a pre-arranged objective was reached when A and B Brigades would be leap-frogged by C and D. The two latter brigades would continue the advance while the two former remained in their present respective areas improving roads and constructing heavy bridges capable of carrying all transport, including tanks, and taking over and organizing captured R.E. parks, water systems, etc.; and, when their work was finished, the leap-frogging process of the two forward brigades again took place. The advantageous results from this method of working are obvious—the same men on the same job until its completion, continuity maintained and no waste of labour or material, a pre-arranged plan definitely followed and always under the one responsible head with no detrimental effects of dual control, each brigade alternately employed on front line and rear area work and, finally, change and relief for officers and men.

In conclusion it may be stated that, in February, 1919, the question of the reorganization of divisional engineers came before the War Office Committee sitting on the Re-establishment of the *post-bellum* Division of the British Army in the Field. At that time the Canadian organization received the very careful consideration of the Committee and it is understood that in their final report they recommended the adoption, in a modified form, of an organization more or less similar to that discussed in this paper.

THE USE OF INVENTIONS IN WAR.

By CAPT. AND BT. MAJOR G. LE Q. MARTEL, D.S.O., M.C., *p.s.c.*, R.E.

A POINT that is often raised in discussion is the question as to whether it is possible to gain a great victory by the use, as a surprise, of some invention. Doubt is not usually expressed as regards the possibility of effecting surprise, but as regards the effectiveness of an invention which has not been tested in war. For instance, the statement has often been made that the tanks in the Great War were not really effective until they had been tested and altered as the result of trial in war. It is then given as a considered opinion that a "Cambrai" battle, on a wide front, with tanks, could not have been successfully launched in 1916 before the tanks had undergone a trial in war. It may be true that such an attack could not have been launched, but the reason given is totally wrong. It is a matter of fact that the tanks used at Cambrai were for all practical purposes the same mechanically as the Mark I tank used in September, 1916. It is true that the rollers had been strengthened to stand the pavé roads in France, and the steering wheels in rear had been abandoned as not worth the bother of fitting, but these were minor alterations, and were not improvements due to the test of war.

The difficulty of launching a surprise tank attack in 1916 was not due to any mechanical weakness, but was a matter of psychology. The senior officers in the Army at that time were lacking in modern engineering or mechanical knowledge. They looked with suspicion on this new mechanical weapon, and although they were very anxious to use this weapon as an auxiliary to help the infantry in any possible way, yet they would have opposed the idea of using the tank instead of preliminary artillery bombardment to enable the infantry to cross the wire entanglements. Even in 1917 at Cambrai one senior officer declared that his infantry were about to be murdered by this idea of using tanks instead of a preliminary bombardment. Other than this there is no reason why tanks should not have been used in 1916 on a wide front in a surprise attack and to lead the infantry to a decisive success.

And so it is with all inventions. Given leaders with modern ideas and ready to employ new methods under modern conditions, there is no reason whatsoever why an invention prepared in peace time or in war should not be launched on a large scale against the enemy and effect decisive results, provided the element of secrecy can be maintained. That secrecy can be maintained has been shown repeatedly,

vide the use of gas by the Germans and the employment of tanks (though on a very small scale) by ourselves in 1917.

If we are agreed that an invention can produce decisive results, then inventions are one of the most important considerations in any army. The difficulty, however, does not lie so much with the production of the invention as with knowing what to invent, as the following instance will show.

Before the Great War Colonel J. F. C. Fuller predicted that in the next war there would be long lines of trenches protected by barbed wire, and that the main problem would be how to attack the machine-guns behind this barbed wire. General E. D. Swinton laid emphasis on much the same point in lectures to cadets at Woolwich. If, now, some branch of the General Staff had been given the task of enunciating what would be the main problems of the next war, there is more than a chance that they would have come to the conclusion that Colonel Fuller and General Swinton were right, as indeed they were. This work of discovering what are the main problems of the next war is entirely a soldier's duty; it is the prelude to all inventions and the development of such inventions. Unless these ideas have been worked out and unless the Staff have a clear idea in their minds as to what will constitute the main problems of the next war, many opportunities will be missed. For instance, some inventors in 1908, working on the idea that the main problem of the next war would be how to attack the man in a trench behind barbed wire, produced a tractor which was very similar to the war tank. The possibilities of this tractor were demonstrated at Aldershot, but, as the Staff had not cleared their minds as to whether this was or was not likely to be a main problem in the next war, they took no interest in the trials, and the experiments were dropped.

We have, therefore, arrived at this position, that the General Staff must decide in their minds what are likely to be the main problems of the next war. Some of these problems are obvious, such as the desirability of inventing some means of bringing down an aeroplane, but most of these problems are much less obvious. Several problems suggest themselves, but much work is required to be done in sorting them out and discovering which are the most likely problems of the next war. Having decided on one or more as the most likely problems of the next war, the work of invention can begin in secret, and there is then a fair chance of an early and decisive success in war.

Having agreed that a new and secret invention may give decisive results in war without the publicity which is unavoidable with war tests, we can now discuss the best methods of developing an invention. There have been many inventions of war in the past; some of these, such as the invention of the gun, were developed so slowly that secrecy was out of the question. Others, such as gas and tanks, were developed more rapidly, and might have given decisive results if the

soldiers had not insisted on the war test. But in no case has the invention been developed as rapidly as it might have been, and this is important, because rapid development is a great assistance to secrecy, and surprise depends on secrecy. Development has, of course, always been opposed by the Tories and by financial stringency; these are inevitable obstacles. But it is equally true that the development has in many cases been guided by men who had no experience in such work and the progress was consequently retarded. In this we have an obstacle which we can overcome comparatively easily. It is, therefore, proposed to discuss briefly the steps through which an invention has to pass from the original idea until it reaches practical realization. Lack of knowledge of this process has been the main cause of delay in the development of nearly every invention.

It is not only in the development of a new invention that we want rapid progress. A new invention may produce far-reaching results, but modern weapons which are slightly ahead all round of those possessed by the enemy are bound to produce a very substantial advantage. The development of new inventions and the improvement of existing arms and equipment go side by side. It is only possible in peace to re-arm an Army at fairly long intervals, owing to the expense involved, but this does not prevent the development of improved arms and the construction of nothing but the very latest pattern in the event of war. This means a great deal of careful work and trial in peace time, so that the best type and model of every arm is ready and can be handed over to mass production the moment that war is imminent. The following paragraphs, therefore, apply equally to the development of new inventions or the production of improved models of existing arms and equipment. Both are of great importance in the event of war.

Every invention passes through four stages in the progress to practical reality. These stages are :—

(i) The stage of pure research.
(ii) The stage of applied research.
(iii) The design stage.
(iv) The production stage.

We will take these stages in turn and examine them in some detail.

Pure research.—Pure research is the seeking after knowledge without having any definite invention in mind. For instance, the discovery of Hertzian waves was the result of pure research carried out by Professor Hertz, and this discovery led to the invention of wireless telegraphy, but Hertz had no idea of inventing a method of telegraphy when he carried out his work of research. As a rule the work of pure research has little to do with the soldier ; the work is much best left to civilian bodies, such as the National Physical Laboratory. The result of their work is always available if it should have

any military application. In the case of inventions for war the General Staff must set the problem, and the inventor then seeks among the results of pure research to find something which may lead him to his invention. For instance, 50 years ago the soldier might have stated that one of his main problems was to find a means of communication between two headquarters which could not be connected by wire or visual signalling. The inventor should then have searched among the results of pure research and the Hertzian waves might have suggested to him a solution to the problem. As it happened, in this case the solution to this problem was equally important for commercial purposes, and so the invention was developed by civilian resources, but this is by no means always the case. As far as pure research is concerned, therefore, our duty is to watch the results and see if they may lead to some invention which may have a military application.

Applied Research.—Applied research is the development of a particular invention, but without making that invention conform to any specification. For instance, about 100 years ago the possibility of obtaining mechanical power by the use of some form of gas engine began to be realized. The possibilities were obvious. Light and economic engines were required for the propulsion of road vehicles and small boats, and engines which could be heavier and more bulky were required for stationary work. But at this stage it would have been quite premature to enter the design stage and endeavour to construct an engine to suit any one particular class of work. What was required was a period of applied research: no one had any idea at that time as to what sort of oil to use or the best way of producing the gas; nor had they any idea as to whether the mixture should be compressed or burnt at atmospheric pressure. The designers had no data, and applied research was therefore necessary. One of the earliest attempts was an engine which sucked in an explosive mixture at atmospheric pressure and the mixture was exploded half way down the stroke. The experimental engine worked fairly well, and a company was formed to produce stationary engines working on this principle. We now know that the principle was entirely wrong; none of the obvious alternative methods had yet been tried (such as compressing the mixture); and it was altogether premature to enter the design stage. The company went bankrupt. This was a very good example of the danger of entering the design stage when insufficient knowledge has been obtained from applied research. After this failure the necessary research work was carried out. In 1862 the Otto cycle was suggested, and later some experimental work was carried out on these lines. By 1876 nearly all the various alternatives had been tried, and a great deal of knowledge had been obtained. It was now possible to enter the design stage with a fair chance of success. Various designs were prepared for car engines, and station-

ary engines, etc., based on the knowledge provided by research work, and these designs were now successful. But the same success would have been reached far more rapidly if all the available energy and money had been spent on research in the first place.

There are plenty of modern examples of the above mistake. For instance, in 1918 it was desired to construct a tank that was very fast and could swim across rivers and cross wide trenches. A tank of this nature was a totally different proposition to the construction of any type of tank or tractor that was known. No one had any idea as to the best type of track or transmission to use, nor how to steer such a tank. What was required was a period of applied research to provide some data. But, owing to war pressure, an attempt at design was made after a few preliminary trials. The tank was made, and gave some startling results, but proved in the end to be a failure. It contained some wrong principles for a tank of this nature. Then came the peace, and the mistakes should have been realized. Two or three years of applied research would have shown us how to overcome the difficulties, and we should by now have been in a position to design a tank to fill this specification. As it is, the whole of this time was lost. It is true that a very useful tank, constructed on the lines of the war tank, has been produced, but this comes nowhere near to the specification that we require, and it is impossible to construct a tank on these lines that will do so. We could have designed a tank such as the present new tank four years ago, and in the meantime we should have been carrying out applied research to give us the necessary data for designing a far better tank.

The Design Stage.—When sufficient knowledge has been collected, the design stage starts. It is impossible to lay down a definite line between applied research and design, but when we come to the next stage there is a very definite dividing line. It is even desirable to have design and production controlled by two separate branches so as to accentuate the division. When the design has been completed on paper, the munition of war, or whatever the article may be, must be constructed exactly as designed and thoroughly tested under conditions as near to war conditions as possible. This must be completed before production is started. It is an axiom that any new munition which has been designed will produce certain troubles which will require to be put right. It may be that the article is not suitable in some detail for the use by the troops; or it may show excessive wear on some part, or an unexpected stress on some portion of a mechanism, but it is a practical certainty that a new design will require at least minor alterations as the result of trials. Just as a child has to go through measles and chicken pox and other minor ailments before reaching manhood, so a machine usually has many minor troubles before reaching a stage where it is fit for production. The importance of allowing plenty of time for trials cannot be overstressed.

The cases where great delay has occurred owing to undue haste in these trials are too numerous to mention. If production has been started and some trouble then arises during a trial, the difficulties of curing the trouble may be very great. The engineering industry of this country still laments the great loss in output of munitions dur ng the Great War occasioned by lack of thoroughness during the design stage. Even a minor alteration in design must be most thoroughly tested before instructions are given for this cha nge to be incorporated in the next order for production machines.

The Production Stage.—Lastly, when every detail has been tried and tested, the munition of war goes into production. Only for strong military reasons should any alteration be made to the design after production has started. The most important point as regards production is that every part of the munition can, as far as possible, be made by "mass production." Semi-skilled labour is the order of the day during war, and semi-skilled labour means mass production or nothing. Before the war the difficulty of production was never considered. A munition, such as a gun, was altered and altered so as to produce the best possible gun without a thought being given to production on a large scale in war. During peace time there is plenty of skilled labour and it does not matter how complicated the parts of a gun may be, there will always be sufficient skilled labour to produce the small demands of peace conditions. The result is that during peace time munitions tend to become unsuitable for mass production. This is a great danger, for it means redesigning many parts on the outbreak of a great war. In 1914 the engineering industry was aghast at some of the things which they were asked to manufacture. "Why make them like this?" was their cry. And the answer was that they had "grown" like that as the result of numerous alterations to try and get a perfect weapon. Even if the weapon is not quite so perfect, it is better to have a weapon which can at once be made by mass production, than a weapon in which many parts have to be redesigned for mass production in the event of a great war. Even to-day, though it is only six years since the end of the war, complicated parts are beginning to creep into our munitions; there are pieces of steel which are "cut out like cheese" in some weapons. This does not matter at present, for we are only likely to be engaged in small wars where mass production does not arise, but these points should be closely watched in the future. To do so, it is necessary to have experienced engineers on the design side, and this point is often forgotten. The design branch and the production branch should be quite separate, but close liaison is necessary to ensure ease of production. If the officers in charge are just "good sound men" with a smattering of scientific knowledge, as they are apt to be, these points are bound to be missed.

To sum up, therefore, the following are the main points to ensure success :—

(i) The General Staff must enunciate the main problems of the next war.

(ii) An experimental and design branch must then suggest methods of meeting these problems. The necessary research work must be carried out and then the designs prepared. This must be followed by thorough tests and trials. This branch should work direct under the General Staff, and should be quite separate from any department charged with the responsibility for the production of munitions of war. To carry out this work, the officers must be qualified scientists, electricians or engineers, depending on the type of work with which they are dealing. The necessary secrecy must be maintained.

(iii) The department charged with the production of munitions of war, must be prepared to produce the designs evolved by the above branch in the requisite numbers and within the requisite time for war.

(iv) Given the above conditions, there is no reason why Great Britain, possessing as she does a great quantity of inventive genius, should not achieve a decisive victory at an early stage in the next great war.

THE EARLY YEARS OF THE ORDNANCE SURVEY.

(Continued.)

IV. The Directorate of William Mudge.

William Mudge.—William Mudge was officially superintendent of the Ordnance Survey for 22 years; and even before he was formally in charge there is reason to suppose that he did, as a fact, have a principal share in the direction of the operations of the Survey from the year of its foundation in 1791; for Colonel Williams, the nominal Director, took little or no part in the work. We must picture quite a small department, almost too small to be called a department, consisting, as it did, of two officers and Mr. Dalby or Mr. Woolcot, a working party of artillerymen, a few surveyors and draughtsmen from the Ordnance, and one or two engravers. During Mudge's lifetime the object of the Survey remained the production of a one-inch map of Great Britain. Ireland was not originally included in its scope, and large-scale maps had not yet been thought of.

William Mudge was born at Plymouth on December 1st, 1762. His father was Dr. John Mudge, F.R.S., a celebrated physician, the friend of Dr. Johnson and of Sir Joshua Reynolds, both of whom held Dr. Mudge in high esteem. Dr. Johnson was William's godfather. Dr. John Mudge's father was the celebrated divine, Zachariah Mudge, Vicar of St. Andrew's, Plymouth, who was born in 1694. Dr. Mudge relates that when the news of Wolfe's victory at Quebec arrived he hastened to his father (Zachariah) with the Gazette; on hearing the news his father said, "Son, son, it will do very well, whilst the Americans have the sea on one side and the French on the other; but take away the French, and they will not want our protection." He saw clearly, at the moment, in the capture of Quebec, the expulsion of the French from Canada, and the consequent independence of America."* William Mudge was sent to the Military Academy at Woolwich in 1777, and while he was there he was visited by Dr. Johnson, who gave him a guinea and a book.† "Of his time at Woolwich Dr. Hutton said he was a sharp boy, but not particularly attentive. There were at that time . . . two Academies, the Senior and the Junior; over

* *Memoirs of the Mudge Family.* S. R. Flint.

† *Memoirs of the Mudge Family.* S.R. Flint—Truro. Netherton and Worth. 1883. From this book much of what follows is taken.

the first Dr. Hutton presided, and in the Junior a Mr. Charles Green, who was rather remarkable for his slowness in teaching." In 1779 Mudge got his commission as a 2nd Lieutenant in the Royal Artillery, " and was sent out almost immediately to South Carolina where he served in Lord Cornwallis's Army. During this time there is mention made in his father's pocket-book of his writing home from Charlestown." He was promoted 1st Lieutenant in 1781.

On his return from America he was posted to duty in the Tower, and whilst he was there he commenced the serious study of mathematics, being partly moved thereto by the example of his brother officer, Shrapnel. He was helped in his studies by Dr. Hutton, who was thus very well able to judge of his abilities. In 1791, on Dr. Hutton's recommendation, Mudge was appointed to serve under Colonel Williams, who was put in charge of the Survey by the Duke of Richmond. In 1798 Colonel Williams died; his death removed an incubus that might have been fatal to the Survey. Mudge's ability and his experience of the work marked him out as the man to succeed, and he was directed to take charge of the Survey by the following minute:—

" Sir,

I have the commands of the Master-General to acquaint you that, sensible of the zeal and ability you have shown in that part of the Trigonometrical Survey, which it has fallen to your lot to execute on the death of Lieut.-Col. Williams, it was his Lordship's intention to have intrusted to you the conduct of its continuation; and it is with additional satisfaction and confidence that Lord Cornwallis now appoints you to that situation, assured of its coinciding with the wishes of his Grace the Duke of Richmond.

His Lordship desires that you will accordingly take on yourself the charge, as it has hitherto been held by Colonel Williams.

I have the honour to be,

" R. APSLEY."

Although R. Apsley wrote officialese, his meaning is clear enough, and Mudge now became Superintendent of the Survey, and remained in that office until his death.

In the same year, 1798, he was elected a Fellow of the Royal Society; the President, Sir Joseph Banks, informing him that the Fellows " were well aware of the zeal, diligence and ability he had shown in executing the interesting duty in which he was engaged." From 1798 to 1808, Mudge lived at the Tower; in the latter year he bought No. 4, Holles Street, which was his home for the rest of his life.

In 1809 he was unexpectedly appointed Lieutenant-Governor of the Military Academy at Woolwich; but he did not give up the direction of the Survey. " He found the Academy, as he said, in

ruins; to remedy the state of things he at once struck at the root of the evil, and set to work to bring about better discipline, and management, among the Cadets." The appointment was made by Lord Chatham, who, in a letter to Mudge, written in 1817, expresses, not only his high satisfaction at the success with which his Survey continued to be executed, but added that it was "no less gratifying to him to learn that the Royal Military Academy has so fully answered all that was expected from it, and that it has attained that degree of perfection, the accomplishment of which was, he was confident, best insured when it was placed under Colonel Mudge's auspices."

But yet another duty was to be entrusted to this indispensable officer. Since 1798 the cadets for the Artillery and Engineers of the East India Company's service had been trained at the R.M.A., Woolwich. But in 1810 the Company established its own college at Addiscombe, the cadets in question being moved from Woolwich. Colonel Mudge was asked to superintend this new College, in addition to his existing duties. Small wonder that in 1811 we find him writing, "My labours are great and I am without strength to carry my chains. I can assure you that I am a slave, and not wearing golden chains." And again, "I have more business on my hands than I have strength for, or, if I had strength, even time to perform, and this has always been the case." What with his duties at the Tower and in the field superintendence of the Survey, what with his work as Lieutenant-Governor of the Academy at Woolwich, and as Superintendent of his College at Addiscombe, he could have been very little at Holles Street. And it would appear, also, as certain that, in spite of his capacity and energy, the work of the Survey must have suffered but for one fact; and that is, that he had, in 1802, selected, as his chief personal assistant in the direction of the Survey, an officer who was destined to impress his mark very deeply upon that institution, and whose zeal and ability equalled his own—namely, Thomas Colby.

In the summer of 1819 Mudge was promoted Major-General. Early in January, 1820, he was laid up at Addiscombe with some internal complaint. He returned to Holles Street and got better, but had a relapse, rapidly became worse, and died on the 17th April, 1820, in his 58th year. He had married the daughter of Major-General Williamson, R.A., and had five children—one daughter and four sons—two of whom became officers in the R.E., one in the R.A. and one in the Navy. He was noted as a man of great amiability of disposition and evenness of temper; devoted to his family; an excellent chief, kind and considerate; upright and scrupulously attentive to the public interest.

It may, perhaps, be appropriately mentioned here that there is a letter in the Colby collection, written to Colby by Isaac Dalby (then an old man), which confirms the suggestions made above as

to the inefficiency of the first superintendent of the Survey. The letter is as follows :

Farnham.
February 5th, 1821.

" Dear Sir,

I should have acknowledged your letter sooner, but am so much plagued with age and the rheumatism that I feel it very tiresome either to think or write : for the latter disorder the Doctor prescribes flannel and patience ; but I derive little benefit from following his advice—age, indeed, is a growing complaint ; and except one could get a dip in Medea's kettle there is no chance of getting rid of it.

You learn from the publications that I was a fellow labourer, from 1791 to the autumn of 1799, with our late worthy and much lamented scientific friend [Mudge] ; who always was zealous, active, and indefatigable in carrying on the Survey. Independent of his exertions, however, and prominent services in the undertaking, I do not recollect a circumstance derogatory to his character as a gentleman.—But truth compels me to drop eulogy in noticing our colleague Col. W[illiams] who nominally was the principal ; I say *nominally*, because he never made an observation, or calculation, nor did he write a line of any of the printed accounts ; in fact, he proved a dead weight in the undertaking by frequently retarding its progress : and the only time he benefited the service, was when he took his departure to the next world.

I have yet to learn what disorder was the immediate cause of the General's death. I know he had sometimes been subject to the *hyp*, or something like it ; particularly when we were measuring the base on Sedgemoor : at that time he often complained of *depression of spirits*, but found relief from exercise on horseback. It was rather singular, however, that he always got into the most unfrequented parts of the country in his equestrian excursions.

Our routine of proceedings year after year had so much sameness, that I think you may collect what is necessary from the printed Accounts, and more to the purpose than I could furnish from recollection, after a lapse of more than twenty years, at my time of life ; for I now find myself much more dexterous at forgetting than in remembering."

It is, therefore, clear that Mudge was in effective control of the Survey—that is, so far as Williams did not put difficulties in the way—from 1791 to the date of Williams's death in 1798. From that date, until his own death in 1820, Mudge was officially and actually in charge of the Survey. From 1809 he was also Lieut.-Governor of the R.M.A., Woolwich, and from 1810 he was, in addition, Superintendent of the H.E.I.C.'s College at Addiscombe. From the nature of the case, after his assumption of these other duties, much of the direction of the Survey fell into the very capable hands of his friend and junior colleague, Thomas Colby. There is no doubt that the arrangement worked well, as it was bound to with two such reasonable and clever men as Mudge and Colby.

Work in 1799.—One of the first things that Mudge did, after assuming charge of the Survey, was to ask the Royal Society to lend Roy's 3-ft. theodolite. He says that "in very early stages of the work I had frequent opportunities of observing, that eminent advantages would accrue to the service, were the survey prosecuted on a more extensive scale. The consideration of a grand instrument being laid up in the apartments of the Royal Society suggested the propriety of obtaining it; therefore, when my appointment to my present situation gave me the means of effecting former ideas, I lost no time in applying to the President and Council for the loan of their large theodolite." (Probably Williams had vetoed the idea.)

The Royal Society readily granted Mudge's request and the instrument was put into Ramsden's hands early in January, 1799, for the purpose of having new microscopes fixed to it. Ramsden was also asked to complete the zenith sector which had been ordered by the Duke of Richmond in 1795.

In this year, also, Mr. Gardner, the chief draughtsman, was furnished with materials for mapping the north shore of the Thames and the North of Kent. The triangulation during 1799 covered an area, generally north and west of London, of some 5,000 square miles, reaching a little to the north of Coventry, and west as far as Broadway Beacon in Gloucestershire.

Mudge remarks that "the highest advantages would accrue—a word he was very fond of—to geography, were the ideas of the Astronomer Royal carried into execution (and which I shall endeavour to do at some future period), respecting the discovery of the difference of longitude between Greenwich and some very remote point on the western side of the island (St. David's Head, for instance), by means of timekeepers, carried backwards and forwards in the mail coaches."

Position of the Scilly Isles.—The angles to points in the Scilly Isles were observed from stations near Land's End in 1797; and, when the distances were subsequently computed, they revealed a large error in the hitherto accepted longitudes of those islands. Mudge says, "How in a maritime country like our own, where chronometers are in such constant use, so great an error as 26′ 37″ (1m. 46½s. in time), in the longitude, should have remained undetected except by one person, is surprising. J. Huddart, Esq., visited the Scilly Isles, having with him a watch made by Arnold, and obtained his time at that spot, in the island of St. Mary, where the body of Sir Cloudsley Shovel is said to have been thrown ashore . . . he then found a large difference between the real longitude and that published in the *Requisite Tables*."

We shall see that, forty years afterwards, important islands off the coast of Scotland were, before the publication of the Ordnance maps, misplaced on the charts and maps by almost equally large distances.

Terrestrial Refraction.—Mudge devoted much attention to the subject of terrestrial refraction, and, in the account for the years 1797–99, the refraction, in quite a modern way, is given as a fraction of the contained arc. He mentions the great uncertainty and variability of terrestrial refraction and quotes an instance of this in the vertical observations from Pilsden Hill to Glastonbury Tor. It was not found possible to devote very much time to the subject, but Mudge and Woolcot made careful hourly observations at three stations, noting the temperature, air pressure and state of the wind. The mean value of the coefficient of refraction at these stations worked out to about ·09. Mudge says, "the little done on this subject points out the necessity of doing more."

The First Ordnance Map.—By the "first ordnance map" is meant the first map issued, by the Ordnance Survey, for the use of the public. It is stated, in the Account for 1795, that a necessity existed for "completing the Map of Kent for the Board of Ordnance, by order of the Master-General." In the Particulars relating to the operations of the year 1798, Captain William Mudge says that the Survey of Kent was renewed in this year, "as the Master-General had given directions to prepare ample materials for completing the map which meets the public eye with this article." "This article" was read before the Royal Society on 3rd July, 1800. But in the Preface to the Account of the Operations from 1784 to 1796, *i.e.*, Volume I, Mudge and Dalby state that Mr. Faden was permitted "to engrave, under certain restrictions, this Map of Kent for public use. . . . These instructions have been carried into effect, with the assistance of Mr. Gardner, by whom the map has been finished in a masterly manner, and will be published by Mr. Faden in the course of the present year" (1799).

This map of Kent, the first of the ordnance maps, which is thus variously described, was actually published by W. Faden of Charing Cross on 1st January, 1801. It is on the scale of 1 inch to 1 mile and is engraved on copper, in four sheets, each about 33½ inches by 22½ inches. It includes the East part of London, the South part of Essex and the whole of Kent. It is entitled *General Survey of England and Wales, an Entirely New and Accurate Survey of the County of Kent with Part of the County of Essex. Done by the Surveying Draughtsmen of His Majesty's Honourable Board of Ordnance, on the basis of the Trigonometrical Survey.* There is a dedication to Lord Cornwallis and the Board, *by their most obedient and faithful servant, W. Mudge.* The dedication is dated, *Drawing Room, Tower, January 1st,* 1801. The first of the ordnance maps appeared, in fact, on the first day of the new century. Thos. Foot was the engraver, and it is probable that the engraving was done under Faden's direction. Although the hachuring is, in parts, a little harsh, the work appears to be equal to the best continental

THE FIRST ORDNANCE MAP.

From the Map of Kent on the Scale of one-inch to one-mile. Published by W. Faden, 1st January, 1801. Dedicated to the Master-General and Honourable Board of Ordnance, by W. Mudge.

productions of the time, and a good deal superior to the early Cassini maps and the general run of English county maps. It is curious that the next county to be published, Essex, has the title, *Part the First of the General Survey of England and Wales, done by the Surveyors of His Majesty's Ordnance under the direction of Lieut.-Colonel Mudge, of the Royal Artillery, F.R.S.* This is in four sheets, each 23 inches by 34¾ inches. It has the imprint, "*Published April 18th*, 1805, *by Lieut.-Colonel Mudge, Tower. Engraved at the Tower.*" So that by this time the surveyors and engravers were under Mudge's orders, and the maps were published by him. The hachuring of the Essex sheets shows an advance on anything done before, in fact, it had practically reached its final form.

The old hill-hachuring of Cassini's Carte de France left much to be desired: "Mais où la carte de Cassini se montre le plus inégale, toujours médiocre, souvent inférieure aux cartes locales contemporaines, c'est dans la représentation du relief. Les hachures, supposées suivant les pentes, ne sont d'accord ni avec leur raideur, ni avec l'importance des différences de niveau, ni avec les formes du sol. Elles n'expriment guère le terrain, à la manière d'une esquisse très grossière, que lorsqu'il s'agit de vallées d'érosion ouvertes dans l'épaisseur d'un plateau."*

This is exactly the idea that the present writer received from studying the sheets of the Cassini map; before reading Colonel Berthaut's account, he had written that this French map gives the impression of deep river channels in an eroded plateau. The English county maps, published before 1800, usually give the same impression; take, for instance, the interesting map of Wiltshire, on the 2-inch scale, published by Andrews and Dury in 1773, or the map of Essex, by Chapman and André, published in 1777. The Ordnance Map of Essex of 1805 does really, on the other hand, represent the relief almost as well as it is possible to do by hachures; where this system fails is in representing long slopes and gentle undulations. It is not, on the whole, a satisfactory method and is now almost obsolete.

The scale of the Carte de France of Cassini (de Thury) was 1 : 86400. It was begun in the field in 1750, and was finished in the field in 1789, but its publication was not completed until 1815. Napoleon was unwilling that his enemies should possess a complete and detailed map of France—"l'Empereur estimait qu'une carte détaillée est une arme de guerre." Its successor, the "Carte de France au 80,000e", was proposed by Colonel Bonne in 1808; the project was revived in 1814 by General Bacler d'Albe, Directeur du Dépôt de la Guerre, and was supported by Laplace in 1817, who presided over the committee which was the first of many to discuss the

* *La Carte de France*, 1750–1898. Col. Berthaut, Service Géographique de l'Armée.

scheme. The work was begun in 1818; in 1854 about two-thirds of the sheets had been published. The series was not finished until 1875.

These facts are mentioned to give an idea of the slow rate of progress of these celebrated French maps. It was just the same in this country. We shall see that the old one-inch dragged on for more than half a century.

Mudge's Arc of Meridian.—The geodetic operation with which Mudge's name is most closely associated, an operation which, in fact, he largely carried out himself, is the measurement of an arc of meridian from Dunnose, near the southern extremity of the Isle of Wight, to Clifton, a village in Yorkshire, a distance of 196 miles. The objects of this measurement were, first, to determine the varying curvature of the meridian passing through the greater part of England, for use in computing the latitudes and longitudes of the triangulation; and the second purpose was to provide additional information with regard to the figure of the Earth. With regard to the first object it may be pointed out that there was no strict necessity for determining latitudes and longitudes, so far as concerns the making of a one-inch map of England and Wales, or even of Great Britain. For the whole map could have been plotted—as, indeed, it was later on—by a well-known system which is almost the equivalent of assuming a plane earth; and for such a small range in longitude the errors involved in the projection give rise to no practical inconvenience. On the other hand, latitudes and longitudes derived from the Ordnance Survey were required for nautical charts, especially of the coast-line and islands; and it is known that at the beginning of the nineteenth century there was very considerable uncertainty about the positions of the surrounding small islands, especially, of course, with regard to their longitudes. We may, therefore, consider the measurement of this arc as a very proper operation, and a necessary one, if full use was to be made of the Survey.

Mudge considered carefully the best meridian to choose for the purpose. That which passes through the greatest extent of the land-surface of Great Britain is the meridian three degrees west of Greenwich, but this has the disadvantage of traversing much mountainous country, including the marches of Wales, Cumberland, and the eastern highlands of Scotland, and the observed latitudes along such a line would certainly be much affected by local attraction; so Mudge, in order to avoid a line so likely to involve serious deflections of the vertical, chose the meridian of Dunnose.

The account of the measurement was read by Mudge before the Royal Society, on June 23rd, 1803. It was published in *Philosophical Transactions*, and republished by William Faden in 1804, as the second part of Vol. II of the *Account of the Trigonometrical Survey*.

Many pages of this account are devoted to a description of Ramsden's zenith sector, the remarkable instrument with which the latitudes were observed. This instrument had been ordered by the Duke of Richmond before 1795, and it is stated that Ramsden "from the beginning of the year 1800 till the middle of the following summer, had proceeded with little interruption, except from illness, towards its completion. The whole was brought so near to a conclusion before he died, that Mr. Berge found no difficulty in rendering it sufficiently perfect." It was delivered to Mudge in April, 1802, and, after some days' testing and experimental observation at Greenwich, it was set up on the down at Dunnose on the 9th May. Mudge says that one very material service accrued to himself during the time that the sector was being tested at Greenwich, and this was "the advice and instruction I received from the Astronomer Royal, for the successful management of the sector, by which I scrupulously governed myself throughout the whole of the subsequent campaign."

The zenith sector, Ramsden's last work, was in every respect a noteworthy instrument and a short description of it may not be out of place. It had a telescope eight feet long with a four-inch object glass. Great pains were taken to prevent any flexure of the transit axis. The position of the zenith was given by a plumb-bob, and zenith distances could be read by micrometers for $7\frac{1}{2}$ degrees each side of the zenith. In the observations every imaginable precaution was taken by Mudge; thus, thermometers were read at various levels in the observatory tent in order to correct for any unequal expansion of arc and telescope. It is safe to say that no such accurate observations had ever before been taken in the field. The observations were admirably accordant; the measurement of the celestial arc of meridian between the zeniths of Dunnose and Clifton, by 17 different zenith stars, gave a maximum discordance of 4·19″ and a probable error of 0·18″, an excellent result—achieved more than a hundred and twenty years ago. Mudge observed with this instrument at Dunnose in May and June, 1802, at Clifton in July and August, and at Arbury Hill, in Northamptonshire, in September and October of the same year.

It is curious that, though the title is an Account of the measurement of an *arc* of meridian, in the text Mudge throughout uses the word *arch*, for that portion of the instrument by which the angles were measured; he writes of celestial *arcs*, but instrumental *arches*. In the account for 1800–09 he writes of terrestrial *arches*.

The angles of the great terrestrial triangles, connecting Clifton with Dunnose and the previously executed work in the south of England, were observed in 1800 and 1801 with the 3-ft. theodolite. A base was measured on Misterton Carr, not far from Clifton, in 1801, with Ramsden's two 100-ft. chains. This was the fourth base to be measured during the survey operations, the others being those

measured at Hounslow Heath, Romney Marsh, and Sedgemoor (in 1798), the latter being a base of verification for the work in the west of England. The mean length of the Misterton Carr base was found to be 26,347·7 feet of Ramsden's standard. Allowance for standard being made, this base comes out very well when tested by the final O.S. results. For a discussion of the length of a degree of the meridian Mudge was able to use the well-determined latitudes at Greenwich and Blenheim, as well as those observed by himself at Dunnose, Arbury and Clifton.

The length of a degree of the meridian, in the mean latitude 52° 2′ 20″, was found to be 364,920 feet, a quantity which does not differ much from modern values. But Mudge was greatly concerned to find that the length of a degree in the southern portion, from Dunnose and Arbury, was greater than that in the northern portion, from Arbury to Clifton; whereas, if the earth had the shape of an oblate spheroid, the reverse should have been the case. This was a disappointment to him, as he had hoped that the stations chosen were reasonably free from local attraction. But he never doubted that the anomaly was caused by local attraction, and he was right.

Mudge, in common with the geodesists of his age, treated mountains as supported by the solid crust of the earth; a section of the crust through the mountain being imagined to have just so much extra matter piled on top of it. Now, the modern view, based on much experimental evidence, and chiefly due to the labours of Archdeacon Pratt, in India, some seventy years ago, and of Dr. Hayford, formerly of the United States Coast and Geodetic Survey, in recent years, is briefly this: Mountains are not "supported" by the solid crust; the existence of a mountain may be taken as a proof that there is, in the crust below it, material lighter than the average. In the same way, it appears probable that under the oceans the material of the crust is heavier than the average. Hayford has shown that this compensation, or balancing of high land by deficiency of density underneath it, and *vice versa*, probably takes place within a depth of about 100 kilometres, or 70 miles. So that computations of the deflections caused by the visible topography give results, in the case of hills, which are almost always too great, and are apt to be very misleading. When the effect of compensation is taken into account it is necessary to extend the computations to great distances. Moreover, though the compensation is probably very perfect when large continental areas are considered, it is not so for small areas or for small hill features, and the compensation may be considered to be spread through some distance horizontally. Also, local attractions are largely modified by local, and not general, abnormalities of density which may be only a relatively small depth below the surface.

The general condition of balance is known as *isostasy*. Much

has been written on the subject by Dr. Hayford and Mr. W. Bowie, of the United States Coast and Geodetic Survey, and by Sir Sydney Burrard, formerly of the Survey of India.* But the science of geodesy arrives slowly at its results and finality in the discussion of this matter of isostatic compensation has not yet been reached, though much progress has been made.

We need not, therefore, be surprised that Mudge's measurement of a single arc of meridian, less than three degrees long, did not give minutely reliable results, or serve to determine the figure of the earth. But the combination of many arcs, both along meridians and along parallels, and geodetic observations spread over Europe, the United States, and India, have given us very accurate information with regard to the mean figure, that is to say, the ellipsoid of evolution which will best fit the geoid, or water surface at mean sea-level. We can now say that, though we are still uncertain as to the variations of crustal density and the exact mechanism of compensation, we know the length of each of the earth's semi-axes to within about 100 metres, that is, to within one part in sixty thousand. But in Mudge's day there was no such exact knowledge of the figure of the earth, and the mean curvature which he obtained from his arc was required for, and used in, the construction of the one-inch map.

Although Mudge had not the solution, he had perfectly clear ideas as to the nature of the problem. In the Account printed in 1801 he says, with reference to "the uncertain state in which we remain, with respect to the figure of the earth": "If the earth were homogeneous, it would necessarily be an ellipsoid; and, were its diameter known, the longitudes and latitudes of places on its surface might be accurately computed, provided their geodetical situations were correctly ascertained, and the latitude of one station in the series of triangles truly determined.

"As there is, however, great reason to suppose that the earth is not any regular geometrical figure, from the impossibility of reconciling the results of the various measurements . . . some uncertainty must remain with respect to our deductions; but there seem to be reasons for supposing the errors . . . are confined within moderate limits."

Simon Woolcot.—Writing in 1800, Mudge said that "whilst I lament the loss of a man [Dalby] so perfectly calculated to assist me in this arduous undertaking, I derive every consolation from a knowledge, founded on experience, of the talents and abilities of Mr. Simon Woolcot." Woolcot joined the Survey as mathematician and observer, in succession to Dalby, in the latter part of 1799, and his service was continuous until his death in 1819.

* See also *The Earth. Its Origin, History and Physical Constitution.* by Dr. H. Jeffreys, M.A., D.Sc. University Press, Cambridge, 1924.

A few of Woolcot's letters have been preserved and these throw some light on the experience of the field-workers in the early part of the nineteenth century.

On the 4th May, 1804, he writes to Mudge from South Molton :—

"A considerable time has elapsed since the Draughtsmen of the Tower were favoured with Warrants, from a recommendation of the Master-General, as a measure highly expedient to facilitate the execution of Military Surveys, etc. I must say, I feel a considerable degree of uneasiness, as I have not received the favour of a similar indulgence, since the authority of a warrant is now become so necessary to guard me, particularly on the coast, from those insults and interruptions, in the execution of my business, which I have so frequently and so lately experienced. . . ."

On the 22nd December, 1812, he writes to Colby from Kimbolton :

"The weather . . . set in so unfavourable that notwithstanding my waiting day after day for a change I was at last compelled to return without having completed what I intended when I set out. I have returned with a slight cold and a broken Gig—however, it does not require much fortitude to reconcile oneself to accidents like these. I was sorry to find Mr. Gardner on my return so long waiting. . . . He wishes to have your permission to proceed immediately with the Survey of Norfolk. No coach passing through Kimbolton for London this day, Mr. Gardner is under the necessity of delaying the sending the Diagram of his triangles until to-morrow.

"With respect to Messrs. Hyett and Stevens I think the most convenient edge will be from Towcester on the main road in a straight line through Watling Street the old Roman way. . . ."

In the next letter there is a sentence which shows that some of the work was carried out in the field on the one-inch scale. Woolcot, writing from Kimbolton on 27th November, 1812, says :—

"Since I received your last letter I have recomputed the Cambridgeshire triangles and will lay them down on the inch scale for Mr. Yeakell as soon as possible."

In another letter, of about the same time, but undated, he gives the "latitudes" and "longitudes," *i.e.*, the co-ordinates, of certain points in Scotland, namely, Kellie Law, Red Head, Bell Rock, Dundee Law and East Lomond, with reference to Delamere ; showing that it was then intended to plot the one-inch map of Great Britain from one origin. Later on this excellent idea was given up. He ends the letter :

"I wish you fine weather for your zenith sector observations that you may not be detained long in the inhospitable Isle of Shetland."

In a letter dated May 5th, 1815, he writes :—

"I sent Mr. Dawson by the coach of yesterday a diagram of the points and distances on the two-inch scale in the neighbourhood of

Dolgelly and Cader Idris. . . . I am happy to learn from you that the United States of America have manifested such a laudable spirit of exertion by procuring instruments from this Country of such transcendent excellence for the prosecution of their Survey. . . ."

On 10th January, 1816 :—

"I am glad you have gotten a Board Order for the payment of the 1/5d. per day, etc."

On July 4th, 1816, from Carnarvonshire :—

". . . Colonel Mudge desired me on my way to Wales to call on Mr. Dawson and to learn from him for what part points would be first wanted. Mr. Dawson informed me that as Caernarvonshire would be principally the business of the present year he could wish to have points for that district as soon as possible. . . . The range of mountains is more extensive in this neighbourhood and of superior bulk and eminence and has also in general a nearer approximation to the coast, which, perhaps, may account for a greater attraction of the humid vapours exhaled from the sea. . . .

"I expect Mr. Dawson will be very soon at Caernarvon as I understand from Mr. Forbes and his nephew Mr. Budgen. . . ."

In this letter he gives his value of the height of Snowdon as 3557 feet.

On July 15th, 1818, to Captain Colby, LL.D., etc., then in Scotland :—

"Good and evil are intimately blended and inseparable in this life, both in action and in sufferance. Your future almost inaccessible positions will supply you with an antidote of some small efficacy, . . . it will perfectly free you from all disagreeable intrusions. All those swarms of idle holiday visitors will visit you no more, they will remain at home, like flies from tempests all couched under shade. . . . I have not heard from Colonel Mudge since I left Town. I have informed him in what manner I intended to proceed with the internal survey. . ."

At Macclesfield on December 22nd, 1818, to Capt. Colby :—

"So long a time hath elapsed since I received a letter from you that I feel very uneasy on the occasion. I wrote to you at the Tower about five weeks since on the supposition you were then returned from your expedition to France with the Zenith Sector. I wish to observe that the approaching winter would not allow me to finish the high Peak of Derby. . . . I wrote to Colonel Mudge previous to his going to France that I was in want of Paper. . . ."

The following letter was written to Capt. Colby by William Woolcot, brother of Simon, shortly after the death of the latter :—

"I have this moment received your letter of the 28th and, conformably to your Order, I have enclosed my dear Brother's last Field-pay; which you will be pleased to hand over to the Board. . . . I mean to pay you a visit at the Tower, and whatever papers I may find in my Brother's Gig-box, relative to the Survey, shall be faithfully delivered

to you. . . . There are also several Books of computed triangles of various Counties, some maps, a Telescope, and one of Beck's patent Protractors, which shall all be returned to you. Besides, I have a good part of the Correspondence between Colonel Mudge and my most affectionate Brother. . . . I, too, should like an inscription over the remains of my lamented Brother, and the following is submitted to your consideration, alteration and amendment :—

" Sacred to the memory of S. Woolcot, Esqr., Trigonometrical Surveyor, who was born at Southmolton, Devonshire, but departed this life, at Macclesfield, while on the Survey, in the certain hope of a glorious Immortality, on Monday the 19th day of April 1819, in the 59th year of his age,—As a man he was amiable,—as a scholar, most excellent ; few were his equals in the arduous field of Investigation, and none his superiors ; but death inexorable, who pays no distinction to persons, title, nor honor, has in a moment laid this sun of genius in the dust!—The last sad tribute of affection was paid to his remains by his highly-respected Friend Captain Colby, LL.D.

" Go ! imitate his Virtues, and become also the heir of Immortality ! Virtue alone will flourish in Heaven when Time & death shall be no more.

" As a memorial of that love, which nothing but death could extinguish, this Tablet was erected by his most affectionate Brother."

A RAPID AND SIMPLE METHOD OF OBTAINING THE MAXIMUM SHEAR AT ANY POINT IN A GIRDER WITH THE USE OF A TABLE OF END REACTIONS.

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

IN calculating the stresses in an N girder or any type of framed girder subjected to a string of rolling loads the difficulty always arises of finding the maximum shear in each of the panels. Finding the worst stress in any member of a frame under any system of loads entails a considerable amount of work. The most accurate and, perhaps, the simplest method, is that of drawing out influence lines for each member. This method is too exact and lengthy to be practicable in the field. The method adopted under certain conditions is to reduce the rolling load to an equivalent uniformly distributed dead load (E.U.D.D.L.). This equivalent load is then used for the purpose of calculating members that resist bending moment only, *e.g.*, the booms, for which it is quite accurate; but in the case of shear members a percentage—usually 15—is added to this figure and the shear then calculated by the usual head and tail method. Now, this method is only sufficiently accurate where the system of loading approaches a uniformly distributed load. This condition is satisfied in civilian work where there are several lines of traffic on the bridge at once and/or where the axle load is small in proportion to the weight of the bridge. It is not, however, accurate in the case of military bridges because this condition is not satisfied. With a single line of traffic the load is anything but uniform and the bridges are usually small enough for the axle loads to be a large proportion of the total load on the bridge. The maximum shear at any point actually occurs when a heavy axle is over that point and the bridge is loaded on one side or the other with the heaviest string of axles that can follow.

Now, in a single line bridge with axles such as a 6-in. gun and tractor with 10 tons on rear and 1 ton on front axles, the E.U.D.D.L. method must fall far short of the truth, and the addition of 15% is absurd as having no relation to actual conditions. To illustrate this, an example is given showing the results obtained by the 15% method and the actual fact. Take a 64-ft. span, loaded as in *Fig.* 1.

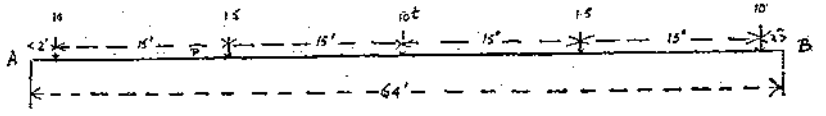


FIG. 1.

This loading approximates to a 6-in. B.L. gun, but is taken symmetrically for clearness. Impact factor has been neglected in this to avoid confusion.

Then B.M. produced by E.U.D.D.L.

$$= \frac{WL}{8} = \frac{33 \times 3^2}{2} - 10 \times 30 - \frac{15 \times 3}{2} = \text{B.M. at centre}$$

$$\therefore \quad \frac{WL}{8} = 205\tfrac{1}{2} \text{ ft. tons,}$$

or

$$W = 25{\cdot}7 \text{ tons.}$$

Then E.U.D.D.L. = 25·7 tons or 0·4 tons per ft. run.

Now let us find the shear 15 ft. from A at a point P.

From above, with the tail at P, moving right, and adding 15% to E.U.D.D.L.,

$$\text{Shear at P due to live load} = \left(49 \times {\cdot}4 \times \frac{115}{100}\right)\frac{24{\cdot}5}{64} = 8{\cdot}64 \text{ tons.}$$

Now, actually, the worst shear is when the bridge is loaded as in FIG. 2.

$$\text{Reaction at A} = \frac{49}{64} \times 10 + \frac{34}{64} \times 1{\cdot}5 + \frac{19}{64} \times 10 + \frac{4}{64} \times 1{\cdot}5$$

$$= \frac{68}{64} \times 10 + \frac{38}{64} + 1{\cdot}5$$

$$= 11{\cdot}5 \text{ tons.}$$

which is the shear at P due to the live load.

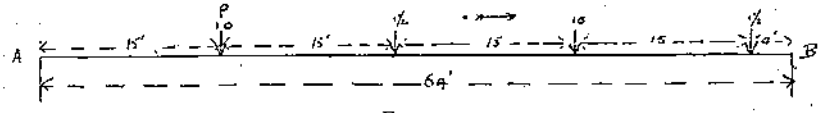


FIG. 2.

∴ the E.U.D.D.L. method is less by nearly *three tons*, or an error of 25% *after* adding the 15% factor. It is clear, then, that this method might lead to failure of a bridge if very eccentric loading were met with.

The method suggested below is shorter than the ordinary head-and-tail method and is equivalent to working out the shear at any point for any system of loads; but advantage is taken of the fact that these calculations have already been made for the Table of Max. End Reactions that will appear in the Manual. This Table of Max. End Reactions shows the max. end reaction for all spans up to 150 ft. for all military loads, by classes, up to tanks. (A Table on these lines is appended.) It has been computed by placing

the loads in the worst possible position for shear at the end of a girder; that is, with a heavy axle on the abutment and a stream of axles following in the worst possible order.

Now, if we desire to find the shear on a girder AB at any point P,

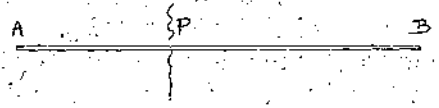


FIG. 3.

the shear will be a max. either when the head of the load has reached P or the tail is at P. If the tail is considered to be at P, the worst possible combination of loads is a heavy axle at P and other axles arranged between P and B. This system of loads will produce a vertical reaction at P equal to the resultant of all the loads divided in the correct proportion between P and B. This is exactly similar to the end reaction at P on a beam length PB, similarly loaded. This can be found in the tables. Let this vertical reaction be p tons —then the reaction at the abutment A is $\frac{PB}{AB}p$ tons, which equals the shear at P.

For example—Suppose that an N girder of 10 6-ft. panels is to be designed to carry 3-ton lorries over a span of 60 ft. A timber girder is assumed in this case, an impact factor of 2 being allowed.

Consider the shear in the panel CDKL.

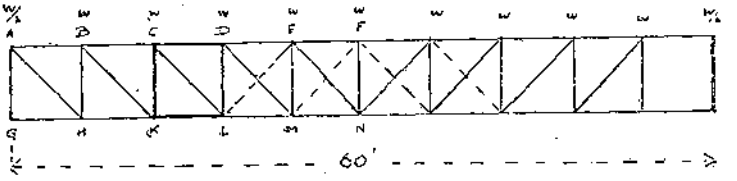


FIG. 4.

The shear is a max. in a positive direction when the tail of the loads is at D, moving right.

From the table we find that max. end reaction on a span of 42 ft. is 13·5 tons (table allows 50% impact factor; factor of 2 is introduced here). Hence

$$R_A = 7/10 \times 13{\cdot}5. \quad \text{Hence shear} = 9{\cdot}45 \text{ tons.}$$

To this would be added the shear due to dead loads only, which is easily calculated as follows:—

Let dead load at panel point = W.

Then $R_A = 5$ W. And shear in panel CDKL $= 5$ W $-(2$W $+$ W$/2)$

$$= 5 \text{ W} - \frac{5}{2} \text{ W} = 5/2\text{W}.$$

The shear with the head at C is calculated in an exactly similar manner, though it is considered as though the tail were at C with the load moving left because the rear axle of a vehicle is always the heavier.

In this case reaction at C is 8·5 tons (from Tables).

Reaction at other end of girder is $2/10 \times 8{\cdot}5$.

$\therefore$ shear at $C = 2/10 \times 8{\cdot}5$ tons in a negative direction.

This must then be subtracted from the shear due to dead load only, *i.e.*, 5/2W to get the nett pos. or neg. shear.

The only inaccuracy in the method is that due to considering the max. shear in a panel as being when the head or the tail of the load is at a panel point, whereas the actual max. is at a point in between, such that this point divides the panel in the same ratio as it divides the bridge. This error is negligible in practice.

The Table is worked out for 10-ft. intervals. An interpolation can be made with sufficient accuracy for intermediate lengths.

It is hoped that this method may be of some use to those involved in bridge calculations for military loads. It has the merit of being accurate and quick and of using the calculations made at leisure in times of peace.

TABLE

CLEAR SPAN IN FEET															IMPACT FACTOR TAKEN	REMARKS	DIAGRAM OF LOADING SCALES VARY
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150			
17	25	28·5	32·3	39·3	44·3	48·5	54·5	60	64·5	70	76	81	86	92	NONE	THIS LOADING NOT ALLOWED ON STOCK SPANS	35 TONS 33' 35 TONS ETC
25·5	37·5	42·75	45·3	46·5	47·7	48·3	48·7	49·2	49·5	46	50·5	53·8	56·6	59	50% UP TO 100' 33⅓% OVER 100'	I F MIGHT BE REDUCED TO 25% THROUGHOUT FOR END REACTIONS	11' 35 Tons 75' 35 Tons ETC 22'
24	24	24	30	33·6	36	41	45	48	52·6	52	53·3	57·3	61·3	64	D° D°	REACTION DUE TO MEDIUM 'B' TANK DISTRIBUTION OF LOAD ON TRACK NOT ALLOWED FOR (I F MIGHT BE REDUCED TO 25%	16 16 16 16 ETC 30' 30' 30'
15	15	15·7	18·6	21·3	23·5	27	30	32	35	33·6	36	38·7	41·35	43·6	50% UP TO 100' 33% OVER 100'	PRACTICALLY THE SAME AS FOOENS ON LONG SPANS	10 1·6 10·1 1·46 10 1·6 10·1 ETC 22' 6'6" 9'6" 11'3" 12'7" 15'6" 22' 11'3"
24	30	32	39	45·6	50	58	63	68	73·6	73	76·4	81·8	88	92·4	50% UP TO 100' 33⅓% OVER 100'	A FICTICIOUS CASE THE WORST POSSIBLE COMBINATION OF 16 TON REAR AND 8 TON FRONT AXLE (INCLUDES STRING OF ANY TRACTORS	16 8 16 8 ETC 10' 20' 10' 3RD TRAIN OF LOADS 1ST TRAIN OF LOADS
7·87	12·06	15·8	20·36	24·3	26·9	28·8	30·36	33·25	36·03	34·2	36	38·4	41	43·3	50% UP TO 100 33% OVER 100'	SLIGHTLY WORSE THAN 6" GUN OVER MEDIUM SPANS	10·1 5·77 8·95 1·05 1·05 10·1 4·13 73 4'9" 19'9" 11'7½" 19'8½" 4'3" 20' 15' 17'6"
12	13·5	15·0	18·4	24·2	25·2	26·6	29·4	32·3	35·1	33·7	36·2	38·8	41·5	44	50% UP TO 100' 33⅓% OVER 100'	THE WORST MEDIUM LOAD AT PRESENT IN THE SERVICE 10 TON ROLLER SINGLY GIVES SAME ON SHORT SPANS	8 4 8 4 8 ETC 15 16'4" 15' 15'4"
12	15	20	24	28·8	33	37·7	42	46·7	51	49·5	53·3	57·3	61·3	65·3	Do Do	A FICTICIOUS CASE THE WORST POSSIBLE COMBINATION OF 8 TON REAR & 4 TON FRONT AXLE	8 4 8 4 8 ETC 10' 10' 10' 10'
8·25	9·6	10·9	13	15	16·9	18·9	20·8	22·9	25·2	23·8	25·6	27·4	29	31	Do Do	THE WORST CASE FOR 3 TON LORRY	5½ 5½ 5½ ETC 13' 15' 13' 15' 13'
8·1	10·5	12·46	15·1	17·88	20·36	22·95	25·68	28·3	30·9	29·5	33	35·4	37·5	40·4	Do Do		
3	4	4·7	5·6	7	8	9	10	11·3	12·4	13·8	15·0	16·3	17·5	18·8	NONE INCL'E IN 5 CWTS		5 CWT PER Ft RUN
3·41	4·68	5·55	6·69	8·0	9·81	10·96	12·16	13·68	15·09	14·45	15·6	16·8	18·1	19·2	50% UP TO 100' 33⅓% OVER 100'	THIS IS THE WORST 2 TON AXLE LOAD POSSIBLE (NO HORSES ASSUMED	2 2 2 ETC

THE ROYAL ENGINEERS IN BRITISH COLUMBIA.

THE following address, given by Judge Howay at the Nineteenth Annual General Meeting of the Corporation of British Columbia Land Surveyors, on the 8th January, 1924, and published with the Report of the Proceedings, has been sent to a correspondent by Mr. R. P. Bishop, who served as an officer in one of the Field Survey Battalions during the Great War. It is republished in full, as giving a remarkable tribute to the energy and versatility of the Sapper. The accompanying photographs have also been recently received, by the Commandant S.M.E. (Major-General P. G. Grant, C.B., C.M.G.), whose father, Colonel J. M. Grant, is repeatedly mentioned in the address, from Mr. A. W. Davis, Resident Engineer, Mineral Survey District No. 3 (Kamloops, B.C.), who served in the 171st and 177th Tunnelling Companies, Royal Engineers, during the War.—(ED., *R.E. Journal*).

ADDRESS BY JUDGE HOWAY.

I have to thank you for the opportunity of saying a few words at this your annual meeting, and I have to thank you for the selection of a topic upon which to speak—it is always a relief when someone else does the preliminary work of deciding the subject, and finally, I thank you that you have selected a matter which is connected with the history of British Columbia—the work of the Royal Engineers in this Province, or Colony, as it then was.

In dealing with this question I do not overlook the fact that I am speaking to a body of professional men, and that while they are, as educated men, naturally interested in all those things that go to make up a liberal education, they are particularly interested in those that have special relation to their own chosen profession. And therefore, while I will not pass by in silence the other activities of the Royal Engineers in British Columbia—for that would be to leave a false impression—yet I will naturally stress their achievements as Civil Engineers and Surveyors.

Let me first of all sketch in a little background of history. Of course, I will do this just in a general way, and only sufficient to place clearly before us the condition which this body of soldiers faced when they set out for the then far-away land of British Columbia.

Sixty-five years ago there was a vast inrush of gold-seekers into this land. Let us see if we can picture the region before their arrival. It was in a state of nature—just as it had come from the hand of God—it was merely a vast fur-preserve of the Hudson's Bay Company. Its only civilized inhabitants, some forty or fifty men, in the employment of that Company, scattered in some ten or a dozen forts or trading posts, separated by many miles; their sole occupation, trading with the

Indians for skins and furs. The only other inhabitants, the Indians, almost as wild as the bear and the wolf and the cougar that, like them, roamed the dense forests that covered this coastal region, or the mink and the marten and the otter that fished along the neighbouring streams.

Then, sixty-five years ago, there went out to the world rumours of the existence of gold in the bars of the Fraser River; and there swept down upon this wild land a great tidal wave of miners and all the flotsam and jetsam that invariably accompanies suddenly-acquired wealth. In three months—May, June and July, 1858—between twenty-five and thirty thousand adventurers left California for this new Eldorado. "Never in the migrations of men had there been seen a rush so sudden and so vast." Thus British Columbia sprang into being—no question of evolution or gradual growth—but merely to-day a wilderness, to-morrow a civilized region. All things had to be provided and at once. Houses, stores, wharves, and all kinds of buildings to be erected; stocks of goods and merchandise of all sorts to be supplied; roads, trails, and bridges to be built; means of transportation on land and water to be provided; government to be established; and law and order to be instituted and maintained.

Sir James Douglas (or rather, plain James Douglas, as he then was), who was the head of the Hudson's Bay Company on the coast and the Governor of Vancouver Island, a separate Colony, was also offered the governorship of the Mainland. Having accepted, he was much exercised on the question of changing the wilderness into a home of civilized man and at the same time keeping in order the lawless element; for many of the new-comers had reputations none too savoury in the land from which they came.

Writing to Sir E. B. Lytton, on 19th August, 1858, he said: "The affairs of Government might be carried on smoothly with even a single company of infantry; but at present I must, under Providence, depend in a great measure on personal influence and management—a position inconsistent with the dignity of the Queen's Government."

A similar thought appears in the mind of Sir E. B. Lytton, the novelist, who was then the Secretary of State for the Colonies. In a letter to Douglas, written in July, 1858, he says "that he intends sending to British Columbia by the earliest opportunity an officer of Royal Engineers (probably a field officer with two or three subalterns) and a company of Sappers and Miners made up of 150 non-commissioned officers and men."

Later Sir E. B. Lytton enters into the reasons for selecting the Royal Engineers for this duty: "The superior discipline and intelligence of this force, which afford ground for expecting that they will be far less likely than ordinary soldiers of the line to yield to the temptation to desertion offered by the goldfields, and their capacity at once to provide for themselves in a country without habitation, appear to me to render them especially suited for this duty; whilst by their services as pioneers in the work of civilization, in opening up the resources of the country, by the construction of roads and bridges, in laying the foundations of a future city or seaport, and in carrying out the numerous engineering works which in the earlier stages of colonization are so essential to the

progress and welfare of the community, they will probably not only be preserved from the idleness which might corrupt the discipline of ordinary soldiers, but establish themselves in the popular goodwill of the emigrants by the civil benefits it will be in the regular nature of their occupation to confer."

The detachment was sent out in three principal sections; first, Captain Parsons and twenty men; second, Captain Grant and twelve men; third, Captain Luard and the main body. Those accompanying Captain Parsons were principally surveyors; those accompanying Captain Grant were principally carpenters. These two bodies came by way of Panama; as did Colonel Moody, the commanding officer; the main portion of the force, however, came on the *Thames City* around the Horn.

Sir E. B. Lytton took more than a mere official interest in this detachment. He contributed personally to the fund to purchase a choice collection of books for a library—any who remember the old Mechanics' Institute in this city will recall them. It is said that he even made the selection. When Capt. Parsons and his detachment were leaving on the *La Plata*, Lytton came aboard and addressed them. I may take the liberty of a quotation from that rare speech. I do this not only for its connection with my subject, but also that we, as British Columbians, may realize the deep and personal interest in the foundation of this Province which was taken by the author of the *Last Days of Pompeii*. Lytton himself was very proud of being the father of British Columbia; and in 1861 he told the electors of Hertford that he hoped his name would "be remembered in connection with the commencement of a Colony destined to be the wealthiest of all that now speak our language."

It must not be thought that the detachment was merely one of the forty companies into which the Royal Engineers were then divided. It was a picked body, selected out of a large number of volunteers for this service and chosen with a view of having in their ranks every trade and calling that might be useful in such a suddenly formed Colony. It included gardeners, masons, bricklayers, carpenters, tailors, hotel-keepers, tanners, grocers, blacksmiths, photographers, architects, and surveyors; in fact, every walk and avocation in life.

Captain Grant's and Captain Parsons' companies took part in the official launching of the Colony of British Columbia at Fort Langley on 19th November, 1858. Owing to the change from Langley to New Westminster as the headquarters of the force, but little progress was made by these advance parties in the preparation of the Camp for the detachment, with the result that when the main body arrived in April, 1859, only a small portion of the site was cleared and one little log hut erected.

Perhaps as a diversion I might say a word about one of the amusements indulged in by this main body in its long passage from England. This was the publication of a paper, known as "The Emigrant Soldiers' Gazette and Cape Horn Chronicle." It was published "at the editor's office, Starboard Front Cabin, *Thames City*." The editor was that versatile genius, Second Corporal Charles Sinnett. It was all written on large sheets of cardboard. Possibly some here have seen the originals,

which are at present in the archives in Victoria. The handwriting is so neat and regular that it is difficult to believe that it was written on the heaving deck. Captain Luard read the weekly paper to the assembled company every Saturday night. May I be pardoned for introducing three or four verses from "Huthlicaut's Wedding," an original song that was sung by Sinnett and published in the Gazette.

I'll sing ye, lads, a Falkland sang,
Wi' thumpin' chorus loud and lang,
I'll tell ye o' the gleesom' thrang
At Huthlicaut's braw weddin' O.

The first that cam' was Geordie Cann,
Then Osment too and Wolfenden,
Wi' Jock McMurphy, Dick Bridgman,
Cam' skippin' to the weddin' O.

There was Morey too, and Rogerson,
An' Lindsay cam' to join the fun,
An' Smith cam' ere the feast begun,
At Huthlicaut's braw weddin' O.

There was Normanseel an' blithe Woodcock,
And Launders cam' to join the flock,
An' Sinnett wi' his dirty smock,
Gid faith! he marred that weddin' O.

And so it goes on until the poet (?) comes to the description of the feast. The tables groaned, he says:

Wi' haggises an' fine kale soups,
Wi' brandies, wines, and mint juleps,
Wi' gid brown ale full mony stoups,
At Huthlicaut's braw weddin' O.

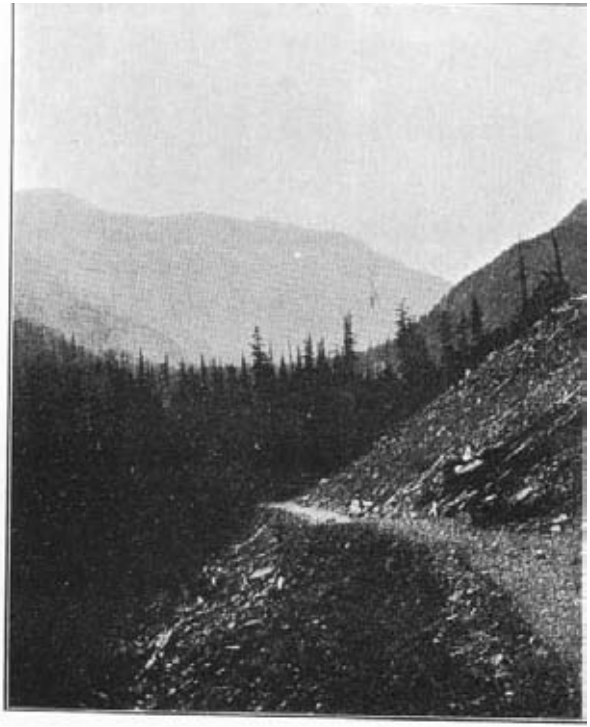
Wi' ham an' beef, an' mutton too,
Wi' Athol brose, an' Irish stew,
Wi' pies an' pasties, not a few,
At Huthlicaut's braw weddin' O.

But now let us glance at the work which this detachment accomplished in the four years and a half that it was in this Colony. I must, of necessity, pass over the part they took in the "Ned McGowan War" of 1859, and in the San Juan trouble of the same year. Both these incidents are interesting, but they lie outside our present boundaries.

The early part of 1859 saw them busily engaged in clearing the site of their camp, building the barracks, married men's quarters, store-houses, offices, and other necessary structures; surveying and laying out the City of New Westminster and preparing the necessary plans with all the neatness and accuracy for which their draughtsmen were famous. Some of Corporal Sinnett's and Corporal Launders' plans prepared at this time are preserved in the archives of the Province and show work so exact and so beautifully executed that it is difficult to believe it was done by hand.

During 1859 the Engineers also surveyed the towns of Yale, Hope and Douglas; and established at their camp an observatory, settling its exact position as 49° 12′ 47″ North Latitude and 122° 53′ 19″ West Longitude. The transit used by them, 12-in. Troughton & Sims, in this observatory is still preserved in the archives. In the same year they built a trail from New Westminster to Burrard Inlet along the line on which, two years later, they built the North Road.

LOOKING SOUTH.



LOOKING NORTH.

Dry wall on Dewdney Trail, seventeen miles south-east of Hope, B.C.; built, about 1860, by detachment of Royal Engineers, and intact in 1924, except where occasional debris has rolled down mountain side.

But the crying necessity was a wagon road to avoid the Fraser Canyons; a trail had been built (before the Engineers arrived) from Douglas to Lillooet, utilizing the stretches of lakes. In May and June, 1859, Lieut. Palmer surveyed a road, and later in the summer a party of almost a hundred men of the detachment was employed in the actual work.

With the same object in view Lieut. Lampriere and a small party explored from Hope up the Coquahalla, thence along the south branch of Anderson River to Boston Bar and along the left bank of the Fraser to Lytton. On receiving their report another party of the Engineers commenced the work of making a trail along this route, which was completed by August, 1859.

In September and October, 1859, Lieut. Palmer explored the country between Hope and the Columbia River. A perusal of his report, which covers ten closely-printed folio pages, will convince the most sceptical as to the careful and systematic work of the Engineers.

1860.

The demand for agricultural land caused Governor Douglas, in January, 1860, to pass a Pre-emption Act. The survey department was kept busy in laying off the lands applied for. Out of this came a drafting department and a record office. The late A. R. Howse was Clerk of Records.

Everyone knows how the lake expansion of Harrison River completely prevents navigation during many months of the year. In March, 1860, Capt. Grant and eighty Sappers commenced to dig a channel through these shoals; and when the freshet drove them out they resumed work on the twenty-eight-mile section which separates Douglas from the Little Lillooet Lake. This was completed by the end of October. Reporting to the Duke of Newcastle, the Secretary of State, Governor Douglas speaks of it as "a work of magnitude and of the utmost public utility which has been laid out and executed by Captain Grant and a detachment of Royal Engineers under his command with a degree of care and professional ability reflecting the highest credit on that active and indefatigable officer."

In the summer of 1860 Sergeant McColl with another party located the trail from Hope towards Similkameen as far as the summit, carrying it over an elevation of 4,000 ft. with no greater single gradient than one foot in twelve. This was the route later known as the Dewdney Trail, because the construction work was done by the Hon. Edgar Dewdney.

Douglas also set out to improve the trail from Yale up the river. Everyone knows that the old H.B. Co. trail led up Yale Creek and down Spuzzum Creek. Douglas determined to follow the river from Yale to Spuzzum, much the line taken later by the Cariboo Wagon Road. Writing to the Duke of Newcastle, the Governor says: "The arduous part of this undertaking—excavating the mountain near Yale—was executed entirely by a detachment of the Royal Engineers under Sergeant-Major George Cann, and it has been completed in a manner highly creditable to themselves and to the officers who directed the operation."

In 1860 also the Engineers surveyed the sites of Lytton and Lillooet. Captain Parsons and a party spent the summer in making a reconnaissance survey of the Sumas and Chilliwack country, for the purpose of its future utilization as farming and grazing land, and to carry out a scheme of the Governor for a road to tide-water. At the same time, the Governor was not satisfied with the existing trail from Pemberton to Lillooet, and the Engineers explored the adjacent country without avail in search of a more convenient route.

1861.

The Engineers in 1861 improved the portion of the Douglas–Lillooet Road, lying between Douglas and Little Lillooet Lake. Here a hill, very steep and difficult of access—Gibraltar Hill—engrossed their attention. Sergeant Bridgman and his party, by means of a cut-off, by decreasing the gradients and turning the road at this spot, so improved it that he was dubbed the "conqueror of Gibraltar." Lieut. Mayne, who travelled over this road soon after its completion, speaks of it as "a wagon road that would be no discredit to many parts of England."

Captain Grant and eighty men commenced in this year the road from Hope to the Similkameen. It followed in a general way the Dewdney Trail of the preceding year. By October it had been completed as far as the Skagit Flats, some twenty-five miles from Hope. The remainder of the trail to Similkameen was merely widened, as a temporary expedient, but before it could be made into a real road the glory of Rock Creek and the southern diggings had paled into insignificance before the wondrous stories of the golden wealth of Cariboo.

There was an air of permanence about the Cariboo mines which, coupled with the constant reports of new rich "finds" and increasing output of old ones and with what was equally important, the demand of the miners for better transportation and cheaper materials and food, caused the Governor to consider a road to Cariboo by way of the canyons of the Fraser. Why that road was not built from Hope is a story in itself. The determination to build from Yale necessitated a careful examination of those sheer and stupendous shoulders of rock which confine the Fraser for miles and miles in the Little Canyon and the Black Canyon. And in 1861 the Royal Engineers made a reconnaissance survey of the whole awful region between Yale and Lytton. Those who glide along through that stretch in the palatial sleeping-cars of to-day need a strong imagination to realize its condition when the Sappers crawled like flies around some of those bluffs to obtain the necessary levels. In the archives of this Province is preserved their sketch of this survey, and also the specifications that they drew for the construction of the road. It was apparent that the Fraser must be bridged, and a party of the Engineers under Sergeant McColl, after due examination, selected as the spot, that on which later the Alexandra Suspension Bridge was built.

It was not a case of all work and no play with the Royal Engineers. From November till March the corps was gathered together into its home at the Camp in Sapperton of to-day. This portion of the year

saw another phase of the versatile Sapper. At the camp a theatre was built and during each winter the members presented from time to time light dramatic pieces, comedies, farces, etc. They were not at a loss even when it came to female parts in their theatrical entertainments; and one or two of the beardless youths obtained quite a reputation for acting in such parts. Dr. Sissall, the bluff and genial and bewhiskered surgeon of the corps, was the admired of all when he used to play Mrs. Bouncer in "Box and Cox." The Engineers also had a social club, the Royal Engineers Club, which during the winter was the scene of many happy gatherings, banquets and dances. Socially the corps was the centre of the social functions of New Westminster in the winter.

1862.

The survey of 1861 having shown that a road up the canyons of the Fraser was feasible though expensive, the Governor concluded to undertake the work, especially as the Douglas–Lillooet Road, with the constant changes from land to water travel and the resultant delays, had never been popular with the travelling public. In May, 1862, Captain Grant, with fifty-three Sappers, began the terrific task, taking as their portion the first six miles out of Yale. By November a magnificent road, cut, or at any rate built, out of the solid rock had been constructed for that distance, connecting there with the road built by contractors. Those who have travelled the remains of this road will endorse John Robson's words: "Some of their work will stand long as the everlasting rocks, an enduring monument of engineering skill and patient toil."

Various other routes—for example, Bute Inlet and Bentinck Arm—strove to compete with the Fraser River Road. To settle the question, Lieut. Palmer explored the latter route. His exhaustive report, like all the reports of these trained men, seems the final word. His minute examination, covering a period of three months, made it clear that the road then under construction through the canyons was far preferable. For fifteen miles the best he could get was an average grade of 182 ft. per mile, a great part of which was over loose rock and precipitous mountain sides. This region was examined ten years later by Marcus Smith in connection with the C.P.R. surveys, but no better route was found.

1863.

The Engineers under Capt. Grant, in this year—1863—located the Cariboo Road from Clinton to Alexandria; but the work of construction was carried on by Gustavus Blinn Wright.

The Governor was not satisfied with the route from the Forks of Quesnel, by Snowshoe Mountain and Antler Creek to Williams Creek—the elevation was too great for winter travelling. Captain Grant then selected the route by way of the Mouth of Quesnel and the Cottonwood. It being approved, the trail was built under his superintendence; the whole sixty-three miles being completed by September, and so passable that the Captain rode the whole distance in one September

day. Lieut. Palmer, addressing the Royal Geographical Society in March, 1864, declared it to be "the one good trail in Cariboo."

Under Lieut. Palmer the Engineers built, during the summer of 1863, the first stretch of nine miles of the Cariboo Road from Spence's Bridge eastward along the Thompson River, where it connected with that constructed by William Hood.

In the Fall of 1863 Joseph Trutch finished the Alexandra Suspension Bridge, but before the Governor would allow traffic to cross he required it to be passed by the Engineers. Lieut. Palmer, after careful examination, applied a sort of rough practical test. A four-horse team with freight wagons containing a load of three tons was driven over the bridge, but the deflection was inappreciable—less than a quarter of an inch.

In this year also a party of the Royal Engineers under Lce.-Cpl. George Turner surveyed the original Lots 184, 185, 186 and 187, upon which a part of the City of Vancouver now stands, and made a complete traverse of the shoreline from Hastings Townsite around Stanley Park into English Bay and False Creek. Incidentally, it may be added that the reservation of that spot is due to Colonel Moody, and thus the citizens of Vancouver owe to the Royal Engineers the largest and most beautiful natural park contiguous to any city in Canada.

In this year the Engineers surveyed the suburban lots adjoining the City of New Westminster, and it was while this work was proceeding that the Municipal Council passed a resolution that the land now known as Moody Square be reserved and known by that name in memory of Colonel Moody.

Taking stock of the work of the Engineers up to October, 1863, when the detachment was disbanded, we find that all the important explorations in the Colony up to that time were made by them; the whole peninsula between Burrard Inlet and Fraser River was surveyed by them; all the surveys of town and country lands were made by them; all the main roads were laid out by them; some of these, including portions of the Cariboo Road, the Hope–Similkameen Road, the Douglas–Lillooet Road, and the North Road to Burrard Inlet, were built by them; practically all the maps of the Colony and of sections of it were made from their surveys, prepared in their drafting office, and lithographed and published by them at their camp; they formed, in 1862, the first building society in the Colony; they designed the first churches (Holy Trinity and St. Mary's, New Westminster, and probably those at Yale, Hope and Douglas) and the first schoolhouse in the Colony; they designed the first municipal coat-of-arms and the first postage stamps in the Colony; they established the first observatory, and to them we owe the first systematic meteorological observations in the Colony; they formed the Lands and Works Department, the Government Printing Office, and printed the first British Columbia Gazette; they aided in the maintenance of law and order; and their commanding officer was the first Chief Commissioner of Lands and Works, as well as the first Lieutenant-Governor.

THE DENNIS-STEVENS PETROL-ELECTRIC LORRY.

By CAPTAIN AND BREVET MAJOR J. D. INGLIS, M.C., R.E.

ALTHOUGH there is at present no official publication on this subject, a chapter has been written for the new *Searchlight Manual*, which explains fully the principles and operation of the P.E. lorry. There are, however, a number of points which are not dealt with and which, in the present writer's opinion, have considerable bearing on the satisfactory working of the lorry.

The first point is brush setting. There is a very wide area of sparkless commutation on the machines employed on these lorries, about $\frac{3}{4}$ in. on either side of the neutral position. When the brushes on any machine are moved, obviously the resultant of cross and demagnetizing turns of the armature is moved with them.

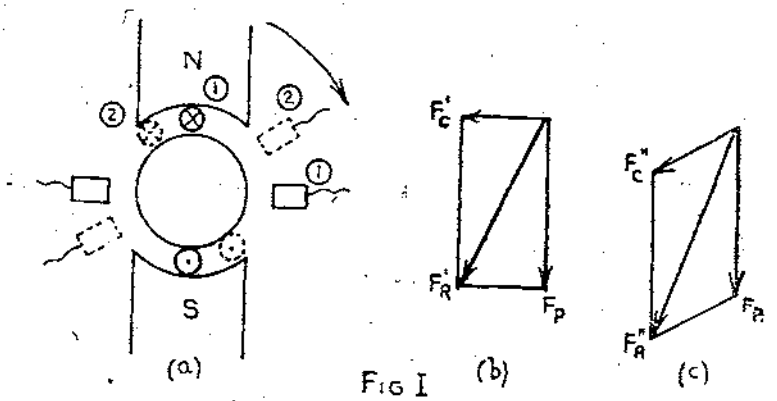


FIG I

Fig. I shows that on a generator, by moving the brushes back against the direction of rotation from (1) to (2), the magnetic flux, due to the cross and demagnetizing turns F_C, is moved so as to strengthen the resultant main flux F_R. Conversely, moving the brushes forward on a generator weakens the main flux. Similarly, by reversing the arrow denoting direction of rotation in *Fig.* I, it will be seen that "brushes forward" on a motor strengthens the field and *vice versa*. The flux due to the interpoles has been omitted for simplicity; a little consideration will show that being equal and opposite to F'_C it actually increases the effect. The fact that the E.M.F. generated is not strictly proportional to the flux F_R, but to that component of F_R which is at right angles to the commutating axis has also been omitted. As long as the angle through which

the brushes are moved is small, this is a reasonable omission, particularly on the generator of the P.E. lorry at starting, which is the important case mentioned later, when the ratio of the field ampere turns to armature ampere turns is low.

The general statement of the effect of brush rocking given above is true of all machines in a greater or lesser degree, but in modern machines, whose field is normally very stiff, the strengthening effect on the flux is small and only operative over a small range of brush positions. In non-interpole machines the strengthening effect only takes place between the neutral axis and the geometrical axis, beyond which the flux is again weakened. The effect, then, of moving the brushes forward is to cause the machine to generate at a lower voltage for a given engine speed. This clearly results in a slightly lower motor speed—in other words, a lower gear ratio. There is, however, a more important effect. At starting before the lorry begins to move, owing to the generator shunt field being shunted across the motor armature, the excitation due to the field is very weak. The effect of the flux due to the cross and demagnetizing turns becomes very marked, so much so that the generator fails to excite at all, whatever its speed, and the lorry refuses to move. The gear ratio has, in fact, become infinitely low. This effect is most noticeable in reverse, where the generator series field is short-circuited, the main field being correspondingly weaker. It is one of the commonest faults in the P.E. lorry and can invariably be remedied by putting the generator brushes back against the direction of rotation. The correct average brush setting, as given by Messrs. Stevens' tester, for the generator is two segments back from the neutral point; the writer, however, finds that this frequently approaches the limits of sparkless commutation. One to one-and-a-half segments gives excellent results from the point of view of starting torque.

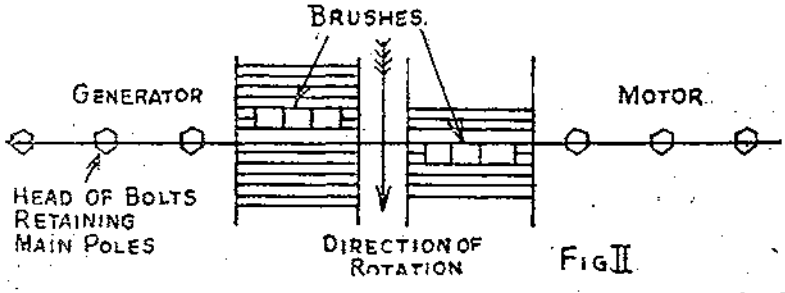


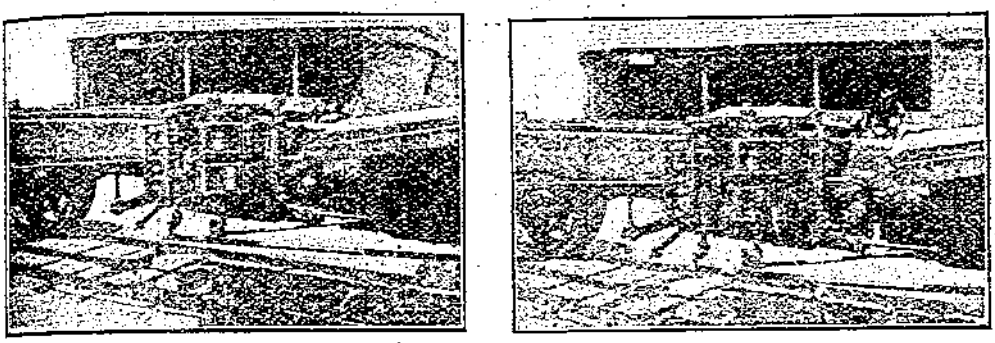
FIG II.

Fig. II shows the generator brushes set two segments back. On the motor "brushes forward" will strengthen the field; this will give not only a slower speed or lower gear ratio, but will also improve the torque and is, therefore, desirable in every way. The correct average brush setting is one segment forward from the neutral point and is also shown in *Fig.* II.

Great care must, of course, be taken to ensure that the limits for

sparkless commutation are not exceeded. The worst condition for sparking is at full load and maximum speed. The motor should, therefore, be tested for sparking at the highest probable speed up a slight incline. The generator should be tested by a stationary run on full load.

It is possible that a lorry may still fail to move in reverse on heavy ground. In such cases the difficulty may be overcome by inserting a resistance in the short circuit path across the generator series windings. This is readily accomplished by placing a piece of sheet iron, preferably rusty, between the lower right hand contacts of the reversing controller as shown in *Fig.* III (*b*).



(*a*) (*b*)

FIG. III.

It is important, if this is done, to put the speed controller in the mid-position; if the speed controller resistance is all in or nearly so, there is danger of burning out the lower elements, which are not capable of carrying the heavy current.

Reversals of polarity of the generator have occurred on these lorries. This may be caused by putting the reversing controller into reverse, while the lorry is travelling forward and *vice versa*. In stationary running a reversal might possibly take place on the sudden application of a very heavy load, if the generator brushes were set too far forward. The writer has no experience of this.

A great deal of difficulty has been experienced in obtaining the requisite power in stationary running. It is at present laid down that 1200 R.P.M. is the maximum permissible engine speed and for most purposes this speed is adequate, but it is interesting to note that the power-speed curve of an engine in average condition does not begin to fall over until the speed reaches 1500–1600 R.P.M. *Fig.* IV shows a power-speed curve taken from an old lorry in only fair condition. This shows that 24 kw. at 110 volts is well within the powers of these lorries.

Good engine speed is essential; it is frequently impossible to get the requisite speed with full field. It should, therefore, be the rule

to run with the strongest field, which will allow the engine to develop the required power comfortably without labouring.

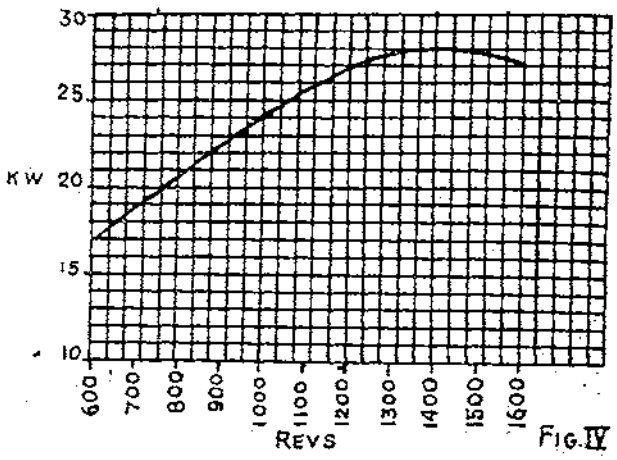


FIG. IV

It is of the greatest importance to have a clear conception of the effect on the voltage of weakening or strengthening the field. Consider first a set running on a fixed throttle position, with a fixed resistance in the external circuit and without governor control; if the field is weakened, the terminal P.D., and consequently the current, will fall momentarily. The engine speed will increase and, provided that it is not at the top of its power-speed curve, it will be capable of developing greater power. The speed, therefore, will rise to such an extent that the terminal P.D., and consequently the current, are greater than they were before.

If, however, the engine had been governed, the speed could not have risen and the terminal P.D. would have fallen.

Other conditions being unaltered, weakening the field will have the following effects:—

(*a*) *Without* governor control, the terminal P.D. will rise.
(*b*) *With* governor control, the terminal P.D. will fall.

This effect is clearly shown by the curves given in *Fig.* V, which are plotted from the readings given in Table I. The heavy lines represent terminal P.D.-excitation and the light lines speed-excitation curves.

The kw.-speed curve given in *Fig.* IV is also taken from those readings.

It should be clearly understood, however, that these curves depend entirely on the condition of the engine; the values cannot be taken to be even approximately correct for all lorries, though the general form, of course, applies to all. Another lorry in average condition gave a maximum of 32 kw. at 1600 R.P.M.

For running with searchlights close governing is most essential.

Governing is effected by an auxiliary butterfly-valve in the induction pipe; the latter is sufficiently large to allow an output of about 50 B.H.P. from the engine. At lower outputs a smaller induction pipe would be adequate and, therefore, it is necessary to close the governor valve a considerable amount before governing takes place. Thus it is necessary to adjust the governor for a particular speed and also for a particular output.

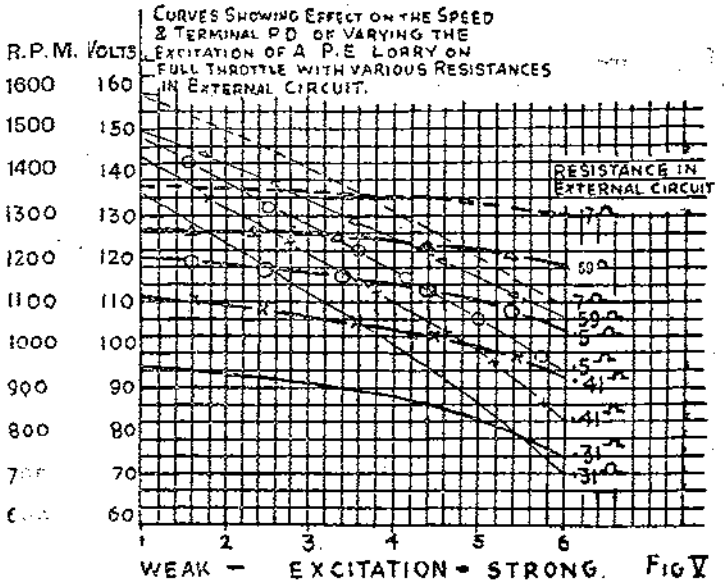


FIG V

The type of governor-adjusting spring fitted to all but the very latest lorries has a very adverse effect on the sensitiveness of the governor. It should in all cases be slacked off, or even discarded. To attain close governing, it is important to minimize back-lash in the governor; this entails careful fitting of the actuating rods and of the governor itself. Unavoidable back lash can be taken up by fitting a light spring, as shown in *Fig.* VI. Increasing or decreasing

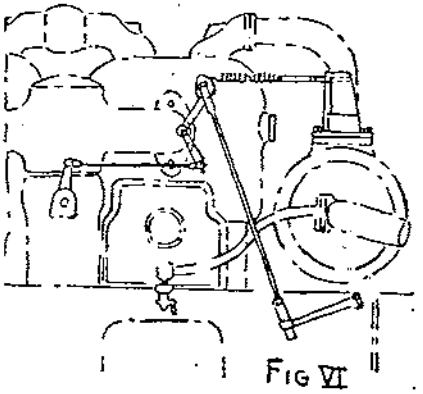


FIG VI

the tension of this spring by the adjusting screw at the right-hand end will also act as a fine adjustment to the engine speed. Governing is, however, quite satisfactory without this arrangement, provided that the old type of adjustment has been removed.

In order to make clear the method of finding the correct position of the speed controller and field regulator, and of adjusting the governor for any given load and terminal P.D., it has been set out below in the form of instructions.

Instructions for setting the Speed Controller, Field Regulator, and Governor for running with a 210 *ampere arc with* 110 *volts at the lorry terminals.*

(1) With governor valve clipped wide open, with full shunt field and speed controller fully retarded, *i.e.*, maximum compounding, place the machine on load, preferably on an adjustable resistance, otherwise on an arc lamp run by a skilful operator.

(2) Instruct the operator or man controlling the resistance to keep the current at 210 amps throughout, by opening or closing the carbons or by adjusting the resistance.

(3) Connect a voltmeter across the lorry terminals and open the throttle wide. As soon as current is steady at 210 amps, read volts.

(4) If the voltmeter reads 112 volts or more, then that is the best position, *i.e.*, full field and maximum compounding. Proceed with governor adjustment, as detailed below in (6).

(5) If the voltmeter reads less than 112 volts, weaken the field either by the shunt regulator or by advancing speed controller or both, until the voltage rises to 112 volts when the current is steady at 210 amps. That is now the best position of the field regulator and speed controller.

Note.—Whether it is better in such a case to weaken the field first by the field regulator and only to sacrifice the compounding as a last resort, or *vice versa*, is a very open question.

(6) Maintain the current at 210 amps and full throttle as before. Loosen the governor butterfly-valve on its spindle and, holding it wide open, connect up the governor actuating rods. Now close the butterfly (anti-clockwise) until the voltmeter, which should still be reading 112 volts or more, falls to 110 volts.

(7) Then clamp the butterfly-valve on the spindle. The governor valve is now set for 210 amps with 110 volts at the terminals.

TABLE I.

Total Res. in External Circuit.	Excitation.																							
	6				5				4				3				2				1			
	Full Shunt Field Max. Compounding.				Full Shunt Field Min. Compounding.				Minimum Compounding. Position of Shunt Regulator.															
									¼ in.				½ in.				¾ in.				All in.			
	V.	A.	Kw.	Revs.	V.	A.	Kw.	Revs.	V.	A.	Kw.	Revs.	V.	A.	Kw.	Revs.	V.	A.	Kw.	Revs.	V.	A.	Kw.	Revs.
·7	132	192	25·3	1080	135	196	26·4	1200	136	200	27·2	1360	138	200	27·6	1400	136	192	26·1	1550	140	200	28	1600
·59	120	204	24·4	1040	124	216	26·7	1200	125	212	26·5	1240	128	216	27·6	1400	129	216	27·8	1440	126	220	27·7	1520
·5	105	216	22·6	960	112	228	25·5	1080	116	228	26·4	1200	119	232	27·6	1320	120	232	27·8	1380	122	232	28·3	1500
·41	94	224	21	840	100	240	24	1000	106	248	26·2	1120	108	248	26·7	1240	111	248	27·5	1320	112	252	28·2	1400
·31	75	240	17	640	84	260	21·8	800	90	272	24·4	1080	93	280	26·2	1200	95	284	26·9	1240	97	290	28·1	1300

INSULATED HOUSES.

By CAPTAIN A. MASON, M.C., R.E.

Cold Climates.—In the May (1924) number of the *Journal of the Engineering Institute of Canada*, a paper on the Insulation of Buildings was published by Mr. James Govan, Architect and Inspector of Hospitals to the Ontario Government. He maintains that the transmission and leakage of heat from a warm room can be reduced to a very large extent by the provision of a suitable lining to the walls and ceiling, and that in a country such as Canada, where the winter is very severe, the designing of houses scientifically with this object in view would lead to very appreciable savings in the cost of heating.

His article is of considerable general interest, and few people will disagree with the trend of his arguments, however unconvincing they may find his figures. These are deduced mainly from the results of experiments carried out at the Armour Institute of Technology, University of Toronto.

He quotes the case of an Ontario Government building in which a saving of 50 per cent. in boiler horsepower was effected by the provision of 10 inches of dry shavings above the ceiling. This is by no means an ideal method of insulation, but the result shows that very considerable improvements are easily obtained. Mr. Govan gives as his considered opinion that, in building a new house, "the total cost . . . of effective insulation will be more than met out of the reduced cost of the heating plant and its first year's operation."

The experiments at the Armour Institute were carried out with a patent material called Insulex, and the results, being based on the heat loss through various types of wall, are not entirely practical, but are useful as an indication of the comparative results which can be obtained. The main saving in costs is, of course, in the capital expenditure on a smaller size of heating plant; this leads to a saving in operating and upkeep costs. The saving in the seasons' coal bill is estimated as a result of the experiments as follows :—

Insulation.	Saving in annual fuel costs over an uninsulated house.
2" insulex on walls and 3" on ceilings	... 45%
3" insulex on walls and 4" on ceilings	... 60%

It is of greater importance to note that the saving in heat loss is practically the same, whether the type of wall to which the insulation is applied is of wood frame and matchboarding, 8-inch brickwork, or 12-inch brickwork.

Hot Climates.—Now the general principles of insulation are the same whether the problem is to keep the interior of a house warm in a cold climate, or cool in a hot climate, and if one accepts Mr. Govan's thesis in general, as applied to Canada, one is led to consider whether such insulation could not be applied practically to the design of houses in India and the tropics.

There are several differences between the two cases which must be investigated. In the first place insulation costs money, and in the Canadian problem the expense incurred is met by the direct saving in heating costs. In the tropics the only saving possible is what might be effected by designing a cheaper house in which the coolness of the rooms is left dependent entirely on the insulation, the walls and roof being reduced to what is essential for structural purposes only. In military works in India, where economy is essential, the value of the suggestion is thus reduced to the problem of whether the savings which can be effected in bricks and mortar will be sufficient to cover the cost of the necessary insulation. This is a problem which can only be solved on the spot.

The application of insulation to an existing building should add largely to the comfort of its inhabitants and would therefore presumably be welcomed by them, but is not likely to be authorized for Government buildings, except for the purpose of bringing up to habitable standard a building previously unfit for living accommodation.

To come down to details: it will be noticed that in the insulex experiments the insulation was not applied with a uniform thickness throughout. Hot air rises and is, therefore, more likely to escape through the ceiling; where the problem is to keep a room warm, insulation is more important on the ceiling than on the walls. To modify this to tropical conditions, it will be agreed that the more a surface is exposed to the direct rays of the sun, the greater will be the amount of insulation required on that surface.

It would also seem that more scientific methods of ventilation should be introduced; it is curious that they have not come into use before now, as the cost would be very small. The people in a room not only breathe out gases at a temperature of about 97° F., but they also heat up all the air around them; when it is desirable to keep a room warm they are assisting in the process, and for that reason a minimum of ventilation is desirable. But in hot climates the warm gases should be removed at once and replaced by cool air. This can easily be effected by an exhaust fan, working in an outlet at ceiling level, and an inlet at ground level for air which can be kept cool by the dripping of water on to a porous screen.

Materials.—In considering suitable materials for insulation, the following table of conductivity coefficients is of interest. The figures have been compiled from various sources in which the data were given in different forms and were to a certain extent contradictory; the

table must, therefore, be considered only as approximate; the coefficient is expressed in gram calories per square centimetre, the difference in temperature through the material falling at the rate of 1° centigrade per centimetre thickness.

Material.	Conductivity Coefficient.
Stone	·01
Brick	·003 to ·002
Glass	·001
Sand	·0007
Wood	·0005 to ·0002
Cork	·0004 to ·0001
Asbestos wool, Sawdust	·0003
Shavings, Charcoal, Felt, Cotton wool	·0002
Pure wool, Silicate of cotton, Balsam wool	·00015
Air	·00005

The first point to notice is that air, which would appear from the table to be an excellent insulator, is by no means so in practice; for its rapidity of movement makes it an excellent conveyor and transmitter of heat.

It is in this respect that the use of insulation may be expected to effect an improvement over the present methods of hollow wall construction. Most of the best materials owe their insulating properties partly to the large quantity of air which they contain in a practically confined state, and movement of the air is only possible by very slow filtration. In most hollow walls, on the other hand, the design permits free circulation within the air space, and leakage in either wall tends to nullify the insulation effect; in the same way the ventilation of the air space, which is frequently provided to prevent trouble from damp, reduces the insulation effect to that of a single wall. Apart from these considerations, economy of masonry can be effected by the application of insulating material to the inner surface of a single wall, where it can be held in place by the plaster.

Requirements.—Cost is, needless to say, of primary importance in the selection of a material, and it is its high price that usually rules out cork in its various forms. For India the transport charges will add largely to the price of an imported article, and, therefore, weight and bulk must be considered in comparison with insulating power.

Weight is also of importance in considering the arrangements necessary to hold or carry the insulation and the corresponding modifications necessary in the design of the house. It may be

possible to obtain a material with considerable structural value in itself, *e.g.*, made up in slabs strong enough to form partition walls without any exterior reinforcement.

A powder has the disadvantage that it is apt to settle, and a vertical insulation may in time develop gaps; this may occur in some materials other than powder and must be guarded against.

Fire resistance should be insisted on; a non-inflammable insulating material would, of course, be of the greatest value in isolating any outbreak of fire, and should, therefore, be considered in designing magazines and stores. Of equal importance is chemical stability; charcoal and sawdust are both liable to spontaneous combustion and should therefore be avoided.

Any tendency to rot, decay or give off smell or gas is undesirable, of course. Insanitary materials like hair felt, which attract and harbour rats and other vermin should not be used.

Both cork and charcoal contain moisture and have hygroscopic tendencies; the ideal insulating material is dry and remains so.

Finally, there are a few practical points to be considered; the brittleness or ductility of the material, the ease of handling or fixing, the thickness available on the market, and that required for efficient insulation.

It will be seen from the above that there are objections of one kind or another to most of the natural materials on the list, and this has led to the manufacture of various types of artificial insulators.

Supply.—There are now on the American market a variety of patent substances which combine many of these desirable properties. Among them are Balsam Wool, Cabot's Quilt, Celotex, Insulite and Insulex, experiments with which have been mentioned above.

The best-known English material is Silicate of Cotton or Slagwool. This is manufactured by several firms as lagging for boilers and steam pipes, and by one firm (F. McNeill & Co., Kirkintilloch, near Glasgow) as "Slagbestos," in forms suitable for domestic insulation. It is similar to cotton wool, with the texture of asbestos fibre, and is made by forcing a blast of air or steam through molten slag. The fibres are said to contain eleven times their bulk of air, and the wool is therefore very light, weighing only 14 lbs. per cubic foot. It is not expensive, costing £4 5s. 6d. per ton at the works, or 6½d. per cubic foot in large quantities; to this, of course, must be added the cost of transport. It is also made up in slabs 1, 1½, or 2 inches thick; the cost of a 1-inch slab varies from 4½d. per square foot with a paper backing, to 6d. per square foot with a backing of expanded metal lathing or fireproof plaster. The fact that if compressed it loses its insulating properties, and the difficulty of giving it resistance against cross-breaking without compressing it, limit its structural value, and the manufacturers state that at present they are unable to make it up into tiles or roofing slabs.

Among the American materials, Balsam Wool and Insulite are both wood fibre products, therefore requiring special treatment to render them fireproof. Insulex, however, is a form of gypsum (plaster of Paris) puffed out, in a similar way presumably to "Slagbestos." It has considerable structural value, a 3-inch Insulex slab under test standing a load of over 23 cwt. over an unsupported span of 2 feet before failing.

Deductions.—It appears, therefore, that some of the materials on the market have reached a state of development sufficiently practical to merit a thorough trial under tropical conditions. Small scale experiments in India to compare the cost and insulating power of various materials are suggested first, followed, if satisfactory, by the construction of a few experimental small houses under conditions which will enable comparison with the existing type of house to be made.

Among the possible modifications of design which insulation may render practicable are :—

(1) A more general use of two or more storey buildings in the plains.
(2) The replacement of a sometimes inadequate verandah all round a bungalow by a more generous one placed only where it is likely to be used.
(3) The construction of bathrooms and outhouses with brick pillars and light insulated panels.
(4) Double roofs of heavy tiles or jack arches will no longer be necessary if plenty of insulation is given above the ceilings.
(5) Scientific ventilation as indicated above instead of the present practice of using an electric fan to stir up a stale atmosphere.
(6) Single walls instead of double.
(7) Insulating slabs faced with plaster used to form ceilings and light partition walls where no weight is carried.

Conservatives may say that a double wall with an air space is all that is reasonable for a house. This system has long been discarded in the design of refrigerators, and there is no reason why house design should stand still. "An Englishman's home is his castle." May we look forward to the time when, in the hot weather, the Sahib's home will be his refrigerator? The American newspapers are already giving space to the subject; full-page advertisements are common, and the *Garden Magazine* shows a house clothed in Cabot's Quilt with the heading "Underwear for Houses." Shall we see in the *Times of India* or the *Pioneer* of the future :—

"Increase your Comfort
Decrease your Drink Bill
Use Frigilite."

THE RUINS OF ANGKOR.

(With notes on the construction of the Khmer Temples.)

By COLONEL C. W. DAVY, C.M.G.

THESE imposing relics of the rich and powerful Khmer Empire, which attained its zenith between the ninth and twelfth centuries of our era, are situated in the province of Cambodia in Indo-China. The French Administration, recognizing the supreme importance of good communications for the development of the rich internal resources of the country, has already constructed an excellent system of roads, based on the classification in force in France, and is energetically extending the railway system. That the roads in many localities are liable to be out of action for several months in the year, owing to floods, is unfortunate, but is to some extent compensated for by the fact that during these periods the numerous waterways are in the best condition for navigation.

Travellers proceeding to Angkor usually land at Saigon, and have the choice, subject to seasonal conditions, of completing the last three hundred miles of their journey either by steamer up the Mekong river, or by road *via* Pnom-Penh. The last section of the latter was still somewhat in the rough when I visited the ruins in February, 1924. The journey by river takes about three days; by car, and with a little luck, it may be done in about twenty-four hours. It is worth while travelling one way, in any case, by steamer, as the scenery and the glimpses of native life along the banks of the river are very attractive.

There is an excellent little hotel at Angkor, run by the Messageries Fluviales Company of Saigon, who make a speciality of inclusive fares for tourists which include transportation, hotel expenses, guides, etc. I was there in the so-called cool season, and the temperature during the middle of the day ranged about 90°–95°, but the evenings, nights and early mornings are quite pleasant. As might be expected in a country containing so many sheets of stagnant water, mosquitoes abound, and all the time I was there I bitterly regretted that I had no breeches and gaiters or field boots with me, as thin socks and trousers present no obstacle to these enterprising insects.

HISTORICAL.

The researches of French explorers and archæologists, and especially of the members of the "Ecole Française d'Extrême Orient," have already borne fruit in an extensive bibliography on the subject of the origin and development of the Khmer civilization, and lately an interesting and original book has been published in English entitled *Angkor Ruins in Cambodia*, by P. Jeannerat de Beerski.* It certainly strikes one that this work might have been considerably reduced in bulk and have gained in interest by the omission of a somewhat insistent personal note and the product of an almost too fertile imagination, but, nevertheless, M. de Beerski has given us an eminently readable volume, in which he resists with considerable success the almost inevitable tendency in a book of this kind to degenerate either into a superior sort of guide-book or a glorified specification.

I was fortunate in making the acquaintance at Angkor of M. V. Goloubeff, who is engaged in archæological researches on behalf of the Ecole Française d'Extrême Orient, and to his little brochure, *Introduction à la connaissance d'Angkor* I am largely indebted for the following historical outline.

The origin of the Khmers or Cambodians† is still obscure, but there seems to be no doubt that, if not of Hindu blood, they had at any rate become Hinduized by infiltration from India, and their earlier temples and inscriptions show that the influence of the Brahmin caste was supreme. M. de Beerski holds the view that, originally followers of Sivaic Brahminism, the Khmers, after some centuries of war and conquest, rising to the zenith of their wealth and power, were inclined to forsake their cruel and ferocious god for a milder and more humane deity; thus Vishnuism succeeded Sivaism and ultimately Buddhism gained an increasing number of adherents and was held in equal esteem with Brahminism, although the latter never seems to have been displaced from its position of what one may call the established church. In that wonderful shrine, the Baion, the inspiration of Sivaism is clearly seen; it is, as M. de Beerski observes, "the soul of a nation petrified."

The great rectangular enclosure now known as Angkor Thom, covering an area of about four square miles and almost entirely given over to dense jungle, marks the site of the ancient capital which, according to the scanty records available, was founded by King Yacovarman *circa* 900 A.D. We have no space to dwell on the vicissitudes of the Khmer Empire during the next three centuries. Monarch succeeded monarch; war succeeded war; temple was added to temple; until in the twelfth century the architectural

* Grant Richards, Ltd., 18/-.

† "Sons of Kambu," the traditional founder of the Empire.

Angkor-Watt. West Façade.

Angkor-Watt. Tower at N.W. Angle of 3rd Story.

The Baion. Angkor-Thom.

THE RUINS OF ANGKOR

zenith was reached with the vast pile of Angkor Watt or "pagoda of Angkor," a "sanctuary where the chief dogmas of a faith are pictorially displayed with consummate feeling, strength and perfection."

After this the story is one of degeneracy and decay. Weakened by perpetual warfare with their hereditary enemies, the Chams, enervated by wealth and luxury, the Khmer Empire was unable to resist the incursions of the warlike Siamese, and from the end of the fourteenth century their innumerable shrines and temples were abandoned to the forest and destruction.

M. Goloubeff tells us the story of the re-discovery of Angkor. It seems that a Dominican monk, in a book printed at Valladolid in 1604, mentions a strange town which the native hunters had lit upon in the depths of the Cambodian jungle about the year 1570.

"This town," he says, "which the inhabitants had neither seen nor known of its existence, is situated in the plain of the Mekong, a hundred and seventy leagues from the sea. . . . It is of wonderful construction and has a very strong masonry wall, four leagues in circuit, on which are represented elephants, leopards, tigers, lions, eagles and dogs. There are numerous inscriptions and letters which nobody can understand. The houses are of stone, very fine, and distributed in regular streets."

We get another glimpse a hundred years later, this time from a French missionary who tells us that the temple of "Onco" (no doubt Angkor Watt) was as famous in those parts as St. Peter's in Rome. It does not appear that any European author again mentions this mysterious city, and it was not until the nineteenth century that the veil was again lifted by a French naturalist, Henri Mouhot, who, in the course of his travels in this region, caught sight, on the 22nd of January, 1861, of the towers of Angkor Watt rising above the tangled sea of foliage.

It would take too long to follow in detail the story, so simply and graphically told by M. Goloubeff, of the interest roused in France by this discovery, of the heroic sequence of sailors, soldiers, administrators, explorers and men of science who devoted themselves, often under conditions dangerous to both life and health, to the deciphering of these fascinating pages of a buried civilization, and to the arduous task of holding in check the ravages of nature. Under the Franco-Siamese treaty of 1907 certain provinces, including the region of the Great Lake, were restored to Cambodia, and thenceforth the custody of the Angkor group of ruins formally devolved on the French government.

The Ruins.

What is known locally as the Angkor group of ruins, with its principal features Angkor Watt and Angkor Thom, includes a

number of other smaller temples and shrines, scattered about in the forest within a radius of four or five miles from Angkor Watt. In their general lay-out they are practically identical. A series of rectangular enclosures or galleries on rising levels leads up to and embraces the central feature, the tower, which is the sanctuary, the holy of holies. Other less important towers were constructed at the angles and the axes of the rectangles, and in the larger temples there is often an enclosing wall and a moat.

Figs. 1 and 2, which are borrowed from the guide-book compiled by M. Henri Gourdon, show the general plan and detail of Angkor Watt, the largest and best preserved of the temples, and which has been described as the supreme achievement of Khmer art.

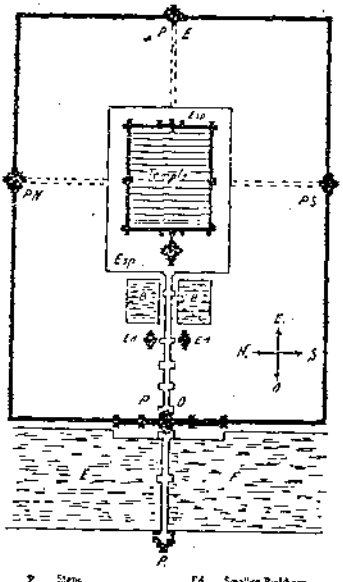


FIG. 1.

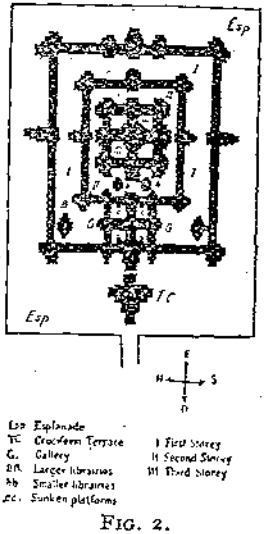


FIG. 2.

Even a cursory inspection of these ruins enables one to realize that, however proficient in the carving of the wonderful series of bas-reliefs and the wealth of floral and emblematic decorations which cover halls and galleries and pillars, the Khmer constructors were woefully ignorant of elementary engineering principles and of the mechanical properties of the materials with which they worked. They had been accustomed to work with timber, and several centuries of experiment do not seem to have taught them that the same methods were not altogether suitable for ponderous structures of stone. To this, rather than the ravages of time, is undoubtedly due the present ruinous state of the buildings which are not older than many of the cathedrals of Europe and far more recent than the monuments of Greece and Rome. That they

had a suspicion that there was something wrong somewhere is amusingly demonstrated by the not uncommon practice of hollowing out a stone transom over a doorway or window and filling it in with a baulk of hardwood.

A laterite conglomerate and sandstone were practically the only materials used by the Khmers, the former for foundations and mass work, and the latter for exposed faces. The use of bricks was exceptional. Both laterite and sandstone came from the quarries of Kowlen, about twenty miles from Angkor. Much speculation and controversy has been indulged in by the French archæologists as to the precise means by which the ponderous monoliths were transported to the site and placed in position. When it is realized that this was and is still a country in which waterways largely take the place of roads, and that the Khmers were no doubt familiar with such simple appliances as the lever and inclined plane, the problem, given a practically unlimited supply of labour, seems fairly simple.

The sandstone is of a soft and friable character, highly absorbent and easily worked, and for the same reason little able to resist the disintegrating effect of a moist tropical climate. Mortar seems to have been unknown to the Khmers, and in their walls and foundations little or no attention was paid to true horizontal and vertical joints and regular courses (*Fig.* 3). Surfaces in actual contact, however, were smoothed and polished with the greatest care, in order to obtain an exceedingly close joint. The weight-bearing capacity of the soil was evidently not a matter which troubled these casual engineers, and we shall see later that failure to distribute the weight properly in foundations was responsible for disastrous settlements in the galleries of Angkor Watt. *Fig.* 4 shows the typical foundation.

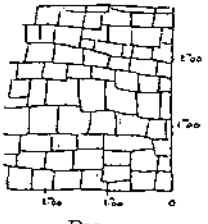


FIG. 3.

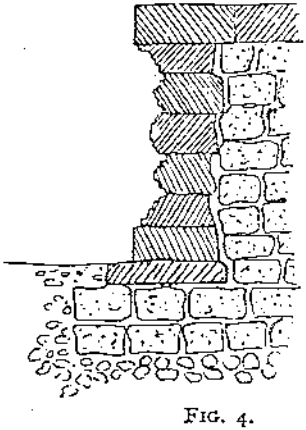


FIG. 4.

The Khmer walls furnish yet another instance of faulty workmanship in the failure to break joint on the straight and the absence of bond

at angles. Openings for doors and windows were treated as if timber frames were intended to be inserted, and the stone transoms and jambs were actually jointed in carpenter's fashion (*Fig.* 5). The window openings were protected by stone pilasters closely imitating the turned wooden bars so common in oriental buildings.

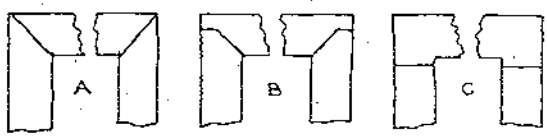


FIG. 5.

Fig. 6 is of special interest. It illustrates the typical gallery with (C) the inner wall profusely ornamented with bas-reliefs, a central row of pillars (B) supporting the main vault, and an outer row of pillars (A) supporting the demi-vault. It will be noticed that the horizontal member between the inner and outer pillars is shown as fractured. In Angkor Watt I counted nearly two hundred of these fractures, all precisely similar in position and inclination. In some places the outer pillar had collapsed altogether, carrying the demi-vault with it, but this was exceptional, and also significant, showing that this horizontal member is not essential to stability. It is, indeed, from the constructional point of view superfluous, and some archæologists regard it as introduced purely for ornamentation, but it is more likely to be only another reminiscence of their older work in timber. For a proper understanding of the mechanics of the problem it must be borne in mind that the Khmers were ignorant of the arch. Their "vaults" were formed merely by the prolongation of the walls with a slight corbelling of successive courses (*Fig.* 7). The gap was covered over by a sort of cap. However

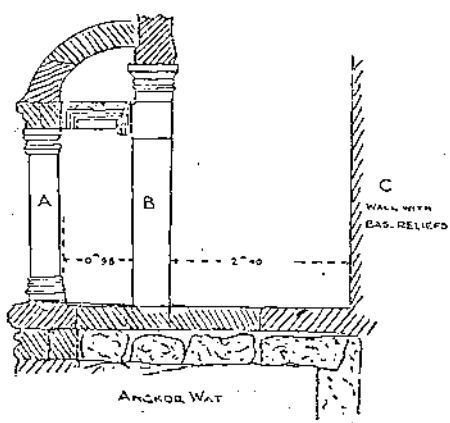


FIG. 6.

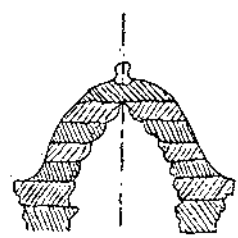


FIG. 7.

indifferent they may have been, however, to regularity in the masonry of walls and platforms, they seem to have realized the vital importance of truly horizontal courses in their vaults in order to avoid a horizontal thrust on the supports.

What, then, was the cause of this almost universal fracture of the " tie-beam " between the inner and outer rows of pillars? It will be seen from *Fig.* 6 that while the outer row of pillars is securely based, the inner row, which carries not only its proportion of the weight of the main vault but that of the outer vault as well, is based on the slab pavement resting on a somewhat vague foundation. The evidence seems convincing that the fracture of the cross beam is due to subsidence of the inner row of pillars, and that the slight displacement of the stones of the demi-vault thus caused led to a horizontal thrust on the outer pillars, which, as indicated in the figure, are a little out of plumb.

Fig. 8 shows a case of an incipient collapse of a vault, instances of which abound among the ruins. *Fig.* 9 shows a typical Khmer tower, constructed after the same fashion as the vaults, but which,

FIG. 8.

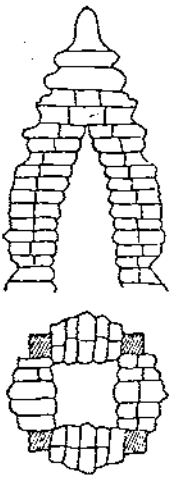


FIG. 9.

owing to the comparatively gentle inward slope, has a relatively larger margin of stability and has survived better than any other constructional feature of the temples.

Ignorance of the true principle of the arch led indeed to disastrous results in the Khmer temples. In other respects also their engineering was defective and the contrast is striking between their incompetence as constructors and the skill evidenced in the setting out of these vast enclosures and such a highly complicated ground plan as the great temple of Angkor Watt, with its series of galleries, courts and towers, on different levels. It would be extremely interesting to know what sort of instruments they used and to what extent detailed

plans were prepared beforehand. Possibly some reader of the *R.E. Journal* may be able to shed light on this point.

To most people, no doubt, the purely engineering features of ancient monuments do not appeal so much as their architectural and artistic beauty, but many writers have already dwelt exhaustively on the latter side of the Khmer temples and the scope of this article would be largely exceeded if I were to attempt to describe their simplicity and harmony of design, their profuse and ingenious ornamentation, the wonderful panels of historical and legendary bas-reliefs, the inexhaustible wealth of artistic fancy in the carving of volutes and curves, of flowers, dancers, gods, demons, horses, elephants, lions and bulls on almost every inch of exposed surface. Words are inadequate to do justice to these products of infinite patience, generations of toil, and, within the limits of technique imposed by the conditions, a high degree of artistic skill. To appreciate them they must be seen and no traveller in the Far East should miss seeing them if he can help it.

In conclusion let me gratefully acknowledge the kindness of M. Henri Marchal, the Curator of the Angkor ruins, who has permitted me to use a number of illustrations from an article entitled "La Construction des Temples Khmers," contributed by him to a French periodical.

THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914–19.

EXPERIMENTAL SECTION.

(Continued.)

CHAPTER 3.—FLARES.

IN December, 1914, the first expedients for illuminating the ground in front of the trenches were tried. They consisted of firework rockets with magnesium stars, shells fired from paper mortars, and hand flares.

The Very pistol, in use at the time to fire the illuminating flare, was not considered good enough, and it was reported that the German pattern and ingredients of the flare composition were better. The Germans also used a hand torch for the purpose.

None of the above expedients were considered better than the Very pistol, and all were unfavourably reported on.

The German flare fired from the "Lichtpistolen," although very similar to our own, was used in such great quantities that its effect was naturally inclined to be exaggerated.

A hand flare, the first ground flare, was tried in February, 1915, but was not favourably reported on, and demands were made on the War Office for a flare which should last at least 30 secs. and light a front of at least 200 yards.

The Germans introduced a parachute light in January, 1915, which seemed to be a great success.

French rockets, after trial by a field company, R.E., were favourably reported on, and Mr. Brock was asked to examine them, and to undertake manufacture of similar rockets.

During November, 1915, trials were held at G.H.Q. with various types from England, and O.C. Experimental Section reported that the Asteroid White floating star rocket was the only pattern which gave sufficient illumination, but was still not as good as the French pattern.

Star shells fired from iron and paper mortars were also tried, but were not found suitable, although the adoption of the paper mortar was urged on account of difficulties in manufacturing sufficient quantities of Very pistols.

About Christmas, 1915, a parachute flare, fired from the 1½-in. Very pistol, was introduced. This gave a bright illumination for

over a minute and rose to a height of about 300 ft. These flares, however, were not issued in great quantities; a ground flare burning on the ground was always preferred to a flare on a parachute, as the latter lit up the firers' trenches as well as the enemy's. This flare was eventually classed in the category of "Signals" and was used for that purpose.

Christmas, 1915, saw the trial of a parachute flare thrown by the catapult, but in March, 1916, this was unfavourably reported on as not being as good as the 1½-in. parachute flare.

Pistol lights were then experimented on at the Central Laboratory in conjunction with the Experimental Section, and improvements were made to the samples submitted by manufacturers, which, although unsuitable for illuminating enemy trenches, eventually resulted in a ground flare which was introduced for purposes of signalling to aeroplanes. This was supplied in four colours, and burned for about two minutes. The first pattern was made up in cardboard cases as illustrated in *Plate* X, *Fig.* 2; but eventually they were made half size, and packed two together in a tin case so as to be waterproof. Owing to the use of nitrates in their composition they deteriorated rapidly if kept in stock. It appeared that, as the nitrate was hygroscopic, internal action was set up directly the flare was exposed to the air, and as it was impossible to fill the flare with absolutely dry nitrate in the factories, slight action was continuously going on inside, even when the flare was not exposed to the air. Experiments in England were continued by the Ministry of Munitions right up to Christmas, 1918, to improve manufacture, but these flares, although used in large quantities, always had this defect.

As a result of ceaseless experiment the flare composition of the 1-in. and 1½-in. Very pistol lights was improved in time, when, owing to a shortage of magnesium allotted for this purpose, powdered aluminium had to be introduced and further experiment was necessary. The work, however, was taken over by the Chemical Warfare Department of the Ministry of Munitions, and the Experimental Section only carried out trials on these stores, and put up recommendations from time to time in connection with their design for use in the field and methods of lighting.

Through the whole of 1916 and 1917, the great difficulty in the supply of these stores was manufacture in sufficient quantities, and manufacturers at home were hard put to it to meet demands of the Navy apart from the Army requirements.

The main object of all flares being to illuminate the ground where enemy working parties were at work in "No Man's Land," they had to comply with two conditions:—

(i) To have sufficient range to fall on the further side of a party in order to silhouette the figures at work, and

(ii) to give as little warning of their arrival as possible.

The Very pistol lights were not satisfactory for this reason, because, although supplied with so-called "dark ignition," the star lit as it left the pistol, and always left a slight trail of sparks which would give warning to an observant sentry.

In the summer of 1916 a flare, known as the "Griffin Percussion Flare," was produced by the Experimental Section, and appeared to meet all requirements. This flare, illustrated on *Plate* X, *Fig.* 1, had a range of nearly 400 yards, fired from the 1½-in. Very pistol; and, having a percussion mechanism, it left no trail in the air. On impact it rapidly lit up the surroundings with a bright magnesium flare lasting about 45 secs. The pattern went to England and large quantities were demanded. However, 500 sent out from England in January, 1917, were tested, and several defects which appeared in manufacture had to be remedied before supply could proceed. So much delay occurred in England with its production that attention was turned to designing a flare to be fired from the recently introduced rifle grenade discharger, and manufacture of the pistol pattern in England was given up. Samples received later in the summer of 1917 were not sufficiently well made to be safe for firing.

Experimental work in France was then devoted to the development of a flare to be fired from the discharger, and several patterns were made. A flare of the same diameter as the discharger would have been too large to reach the required range; but a suitable pattern was made to fire from the 1⅝-in. discharger, which was then being experimented with to fire the No. 34 Egg grenade. This discharger was never actually introduced owing to the development of the percussion grenade; and attention was turned to a projectile in the form of an arrow to be fired from the 2½-in. Mills discharger. Difficulties, however, were met with in France in filling the magnesium into sufficiently small diameter tubing to ensure satisfactory burning, and strong steel tubing was difficult to obtain. A suitable weapon, however, was produced by the Mechanical Inventions Department, who had great facilities for obtaining the necessary materials and packing the composition. This was the Geake flare, first seen by representatives from G.H.Q. in March, 1918, when the O.C. Experimental Section attended the trials at the M.I.D. The flare reached a range of 400 yards and was fairly accurate, and it had a percussion mechanism. The same difficulties were met with in its production in quantity by manufacturers as with the Geake message-carrying rocket (to be described later), both being on similar lines; and it was not until March, 1919, that it was recommended for introduction into the Service after satisfactory trials at G.H.Q., France.

In October, 1917, a suggestion was received from the Third Army to use a 3-in. Stokes mortar bomb filled with Very cartridges for illumination purposes, and this suggestion was transmitted to the War Office. For signalling purposes, timed as it was to burst in the

air, the bomb was satisfactory, and was developed in England by the C.W.D.; but for illumination purposes the stars did not burn sufficiently long, and the C.W.D. experimented with a Stokes bomb filled with flare composition. Delay, however, occurred and the bomb was never satisfactorily developed. The Ministry of Munitions was continually pressed to produce the article, but the difficulty appeared to be that the composition could not be made up to be really safe to fire, as it frequently detonated on shock of discharge. It could be rendered safe for firing by the use of oil, but this increased the time of burning, and the smoke emitted was too dense. In November, 1918, it was reported to be impossible to eliminate the smoke; and, as this was a highly disadvantageous feature, the matter apparently dropped, and no further developments came before the notice of the Experimental Section. The difficulty of causing the bomb to light up with sufficient rapidity was also never properly overcome.

The development of the 1-in. and 1½-in. illuminating cartridges, to fire from the rifle, is described under "Signals," as the stars were used for both purposes.

CHAPTER 4.—SIGNALS.

The history of the early days of firework signals is so closely connected with the history of "flares" that it is necessary to repeat a certain amount of what has been said already under that head.

Very pistol lights were used for illumination purposes, and also for signalling.

White, green and red stars were chiefly used right up to the end of the war. For a long time two sizes of pistol—1-in. and 1½-in.—were in use, but the 1½-in. was ultimately done away with on the recommendation of a Signal Conference held at G.H.Q. in December, 1917. The 1½-in. pistol in a cut-down form was, however, retained for the Cavalry Corps, as referred to later.

Similarly, various types of rockets and mortar signals, of which the illuminating patterns are described under "Flares," were tried from time to time. The types available at the beginning of 1916 were as follows:—

Designation.	
1. (*a*) Shells 5-in. daylight signal—Red.	Red smoke with white stars.
(*b*) Shells 5-in. daylight signal—Blue.	Blue smoke with white stars.
These were fired from 5-in. paper mortars.	
2. (*a*) Flares yellow.	Yellow smoke only.
(*b*) Flares, electric ignition.	

Designation.	
3. Rockets, signal ½-lb. (or 1-lb.)—Blue (or Red, or Green, or Service.)	The 1-lb. rocket contained 49 stars and the ½-lb. 30 stars, Blue, Red or Green.
4. Light long, Red (or Green, or G.S.)	Lasted about 5 minutes—held in the hand—friction ignition.
5. Rockets parachute Large Special—Red (or Green, or White)	Red, white or green stars floating for about 2 minutes.
6. Rockets parachute with coloured stars—Green (or Amber, etc.) intermingled with gold and silver rain.	
7. Rockets parachute with coloured stars—containing 5 stars which change colour.	
8. Shells, Daylight, Japanese, 4-in.	On bursting, liberated figures of animals, etc.

Rockets were satisfactory as far as the signal was concerned, but they were unwieldy to handle and fire, and the trail was objectionable. Mortar signals were preferred and developed, and early in 1917 the 3-star parachute signal was made up in England and tested with satisfactory results. The idea for the design of this signal was taken from the French, and the Ministry of Munitions was asked to arrange for their manufacture late in 1916. Samples were made up by the Chemical Warfare Department and sent to France, and various combinations of colours were tried. Only mortar signals were sent at the time, but these signals were very favourably reported on in May, 1917. The rifle grenade signal with similar coloured stars came out later, and a large demand arose for it at once, as it was found to be a handier article than the mortar signal.

Trials were carried out in July, 1917, to determine which patterns should be eliminated, and which adopted, and very thorough tests for visibility were conducted with a large number of combinations of colours. As a result of these tests the War Office was informed that :—

(i) In 2-star and 3-star signals the colours yellow and white should be avoided, as they are easily confused with green and with each other.

(ii) In " changing colour " signals the first colour should not be white, as, if it is, the signal might be mistaken for an ordinary

Very light, and in consequence might not be under observation when it changed colour.

(iii) Twelve feet is not a sufficient distance between stars in either 2-star or 3-star signals.

(iv) The possibilities of a signal which changes colour twice were worth consideration.

Samples of the following sixteen signals were requested for trial in France :—

(*a*) *Rifle grenade signals with parachute and hanging stars.*

Red over red
Red over green
Green over red
Green over green
} At least 20 ft. between the stars.

(*b*) *Rifle grenade signals, changing colour.*

Red to white.
Green to white.
Red to white to red.
Red to white to green.

(*c*) *Cartridges signal, 1½-in. with parachute and hanging stars.*

As (*a*).

(*d*) *Cartridges signal, 1½-in., changing colour.*

As (*b*).

In addition to these types, experimental signals with coloured smoke (red, blue, yellow or purple) were received during the autumn.

In December, 1917, a conference which included representatives from all armies was held at G.H.Q., when the whole question of firework signalling was investigated. The conclusions arrived at by this conference may be summarized as follows :—

(A) Mortar signals were inferior to rifle grenade signals.

(B) Signals with hanging stars should consist of three stars all of the same colour—reds, greens and whites suggested.

(C) Rifle grenades with red smoke should be retained as an alternative to (B) by day.

(D) Changing colour stars acted very well, but yellow could be dispensed with—" white to red and back to white," and " red to green and back to red " recommended for adoption.

(E) The 1-in. Very pistol should be retained for illuminating purposes chiefly. The 1½-in. Very pistol should be discarded, except a small number for the Signal Service.

(F) Flash signal for the Signal Service for use in combination with visual required.

(G) Also the Signal Service required a special signal in the form of a 1½-in. cartridge bursting into white stars, and designed to illuminate the ground as little as possible.

(H) A Stokes mortar bomb adapted to discharge a shower of coloured lights at a height of about 600 ft. Required as a special signal for use in special operations.

With the development of the discharger, the rifle grenade signal was adapted to fire from it, and this replaced the rodded grenade signal. After much work by the Experimental Section a suitable pattern was evolved; it is illustrated in *Plate* XI, and was called the No. 43 Signal. Supplies were submitted and tested in France in the autumn of 1918, and were passed as satisfactory.

As before mentioned, a special signal fired from the 1½-in. Very pistol was used by the cavalry. The bursting charge of the signal was reduced, so that it could be fired from the 1½-in. pistol held in the hand with the butt removed and the pistol barrel cut down in length; and the weapon was carried in a leather case slung round the shoulder. The signal consisted of a suspended star which changed colour from green or red to white. This signal was not entirely suitable for cavalry work, in which it was required mainly for indicating locality; as it had a parachute it was soon blown away from the correct position in a wind, and the actual locality from which it was fired became difficult to determine. It was, however, used up to the time of the Armistice.

Signals were always the source of much experiment by troops, and one suggestion, received in February, 1918, which was developed, was to fire a 1½-in. Very cartridge from the rifle by the addition of a rod and empty S.A. cartridge case soldered to the base.

Both the illuminating star and the illuminating floating star patterns were made up in this way, and the Experimental Section made about 1,000 for issue to armies for trial. A little later, as a result of experimental work with the discharger, it was found that the 1½-in. and 1-in. illuminating star, though of sensitive composition, could be fired from the discharger with a ballistite cartridge if correctly arranged with felt wads for a cushion. A simple device was worked out and 900 of these were made up (300 each, red, green, and illuminating) for issue to armies for trial. Actually no issues were made owing to the Armistice, but sufficient tests had already been made to show that it was a very simple way of firing the cartridge, and would entirely do away with the 1-in. and 1½-in. Very pistols.

Experiments were continually being carried out in England to improve the ingredients of all signal compositions and produce other colours. A green smoke was experimented with but never materialized, also a blue light, but this colour was too

dangerous to manufacture on account of the fumes given off in mixing.

As regards the special signals asked for by the December, 1917, Conference. The experiments in England with the Stokes mortar types (H) are described under "Flares"; the mortar shell, filled with red and green or white stars, proved to be a very fine signal, but was not developed by the C.W.D. till late in 1918.

For the Signal Service signals, a flash signal made up by the Experimental Section was considered quite suitable for (F) when it was developed after experiment. It consisted simply of a 1½-in. Very pistol cartridge filled with loose aluminium flare composition which, when lit on the ground with a time fuze, projected a bright flash into the air, the cartridge case acting as a mortar. Sufficient quantities, however, could never be obtained from the C.W.D. to give it a trial by armies before the war ended. A flash signal, brought out to France at the time of the conference, consisted of a S.A.A. cartridge filled with flare composition and fired from the rifle. This, however, was not only highly dangerous, but affected the barrel, as the heat developed was too great. Other types placed on the nose of the rifle, and filled with the same composition, did not develop, as they were not satisfactory and were dangerous.

A signal for survey purposes, copied from the description in a captured German document, was called for in August, 1918, and the Experimental Section took the matter up with the M.I.D. in England. After some trial a good signal was produced, but was not in time to be used during the war. It is understood to have been supplied after the Armistice and used for survey purposes. It consisted simply of a tube of flare composition fitted with wings, which was fired from the discharger, and carried a set-back mechanism in its head similar to the rodded rifle grenade signals. It gave a flare as it was projected through the air, and by triangulation with the theodolite from different stations is believed to have proved a useful signal for location of forward positions. In the original German instructions it is described as being a "vertical light-ray" for employment :—

(i) In fixing points during trench warfare.
(ii) In fixing the position of survey posts during mobile warfare.

The O.C. of the Experimental Section was frequently called upon to advise in connection with signals for the Royal Air Force.

Ground flares were used, as previously explained, for Aeroplane-Infantry contact work and, though generally favourably reported on, were not entirely satisfactory. The chief outstanding objection to their use in this connection was the amount of smoke they emitted while discharging their coloured lights. They were used in vast quantities by the infantry to indicate in daylight their positions to

their aeroplane contact patrols, and the smoke emitted by them disclosed their position to observant enemy artillery officers from a considerable distance off. They were superseded eventually by the introduction of a white canvas cover attached to the gas mask haversack, which, when waved by the infantryman, could be fairly easily picked up by the aeroplane observer. Before this, the Experimental Section had made up various forms of fans of ingenious design for the same purpose, but these were discarded in favour of the gas mask flap.

In December, 1917, the Experimental Section was called upon to devise something entirely new in the way of flares for use by aeroplanes to call up the infantry. Something quite distinctive had to be designed which could not possibly be confused with the various signals and flares already in use by infantry and other arms. Several methods were tried in competition with suggestions from other sources. The Section made up large paper parachutes of various colours which could be fairly easily seen, but were not found sufficiently distinctive for the purpose.

Paper concertinas in the form of streamers about 10 ft. long were quite invisible. The flare which was unanimously adopted, and considered by most observers to be the most striking signal ever produced, was the 16 smoke-ball flare. It consisted of 16 smoke balls in two compartments of 8 each. In each side were 4 balls of purple smoke to be seen on bright sunny days, and 4 yellow for dull days when the purple could not easily be seen. The flare was made up in a tin case with a special lighter, both illustrated in *Plate* XII. It was also made up to be fired from the R.L. tube electrically.

The hand pattern was the one preferred and was fitted with a 3-sec. fuze, the lighter being started by the observer pulling the top ring, when the flare dropped and burst below the aeroplane. (See *Plate* XII.)

Eight stars were discharged in one direction and eight in the other, and fell through the sky in the form of long fingers. When thrown from a low altitude (below 800 ft.) they appeared to fill the sky, as the balls emitted trails of smoke till they almost reached the ground, when they went out.

The flare was introduced and manufactured in large quantities, but supplies did not begin in France till about the period of the Armistice. Smoke parachute signals, as used by the infantry, were made up to be thrown from aeroplanes, and also Very pistol smoke parachute flares; but none of these could be compared with the 16 smoke-ball flare.

A Table is appended showing the heights of burst of the principal British signals.

TABLE SHOWING THE HEIGHTS OF BURST OF THE PRINCIPAL BRITISH SIGNALS.

Rockets, 1½-lb. parachute	413 ft.
„ 1-lb. stars	402 „
Rifle grenade signals, 2 stars	308 „
„ „ „ 3 „ (new type) ...	307 „
„ „ „ 3 „ (old type)	252 „
Mortar signals, 3 stars	230 „
„ „ smoke	205 „

Cartridges for Very Pistol.

1-in. illuminating	404 „
1-in. signal	246 „
1½-in. illuminating	511 „
1½-in. parachute illuminating	244 „
1½-in. signal	322 „
1½-in. signal, changing colour, parachute	193 „
1½-in. smoke	248 „

CHAPTER 5.—SMOKE-SCREEN PRODUCERS.

A demand for smoke arose in 1915, soon after the first gas attacks by the Germans.

It was required for two different purposes :—

(*a*) As a dense cloud for the purpose of forming a screen.

(*b*) To simulate a gas cloud.

About July, 1915, smoke cases or candles were obtained privately by one corps from Messrs. Pain & Co. These were used to set up a smoke-screen, and after a few had been purchased, the War Office was asked to send out a number for trial, and further enquiries were made in England for a similar article to produce a denser screen.

Smoke candles were manufactured during the summer as fast as Messrs. Pain could turn them out, and at the same time "P" bombs and bombs filled with a mixture known as threlfalite were also sent out from England.

The smoke candle consisted simply of an 8-in. case filled with smoke mixture, with a hole at one end and a tape friction lighter. The average candle weighed 1½ lb. and burned for four minutes at the most.

It was soon found that these candles did not produce a sufficiently dense screen unless used in extraordinarily large numbers, and a better effect was obtained by the use of red phosphorus spread out in trays—2 lb. every two yards, which lasted for one hour.

A local smoke producer was made up in one army from a mixture of pitch, nitre, tallow and gun-powder; and several hundreds of

these were used to supplement the supply of "P" bombs and smoke candles.

The next development was the use of the 4-in. mortar to fire smoke shells so as to put up a screen over the enemy trenches.

The 2-in., 3·75 mm. and Stokes mortars were also used for this purpose during the winter of 1915–1916, when demands went on steadily increasing.

Up to the beginning of 1917, the following patterns and types had all been tried :—

"P" bomb (red phosphorus).
Fumite bombs (yellow phosphorus).
Smoke cases (Messrs. Pain).
Threlfalite No. 1, and threlfalite No. 2.
Realgar (red phosphorus).
Pelagus mixture.

Weapons Firing Smoke Projectiles.

9·4 mm. mortar.
3·75 mm. mortar.
4-in. Stokes mortar.
3-in. Stokes mortar.
2-in. mortar.
Trench catapults.
"P" bomb rifle grenade.
No. 27 and No. 37 smoke rifle grenades.

Of all these, only the "P" bomb and the Pain smoke case (known later as the "S" case), survived at the end of the war, and among the weapons for firing smoke projectiles the Nos. 27 and 37 grenades and the 3-in. mortar.

Manufacture during 1917 and onwards was concentrated on these, and many millions of the smoke producers must have been made.

The Experimental Section was chiefly concerned in the development of the "P" bomb and No. 27 grenade, as well as in experiments with the Pain smoke grenades and local smoke producers.

In the summer of 1917 a smoke case was made up by the Section to supplement the supplies from England.

This was a very simple type, and required nothing but material available from Ordnance. The usual mixture consisted of 8 parts powder, 6 pitch, 1 tallow and 1 sawdust, and was filled into an empty 18-pdr. shell case. Sometimes tallow was omitted, and the mixture was then gun-powder 5 lb., pitch 6 lb., sawdust ½ lb.—this quantity being sufficient to fill two 18-pdr. cases. Manufacture was mainly undertaken for the coastal operations of the Fourth Army.

About the same time it was found that the Germans were using

a smoke-producing machine for the purpose of concealing battery positions, concentration of troops, etc.

This machine consisted of an iron drum in which chloro-sulphonic acid and quicklime were contained in separate compartments, and when the acid was allowed to drip on to the quicklime a dense smoke cloud was produced.

Experiments were carried out to try and produce a similar result by means of the Experimental Section mixture used in larger cases, but this was never satisfactory, as, when used in large quantities, the mixture was always liable to burst into flame, and to burst open the case. Continuous experiments were carried on in England to develop large phosphorus generators, but were never really successful.

The Navy had produced a satisfactory generator (pitch), but it was required in such large quantities for anti-submarine warfare that none could be spared for France.

At the beginning of 1918 experiments were carried out with a container of chloro-sulphonic acid fitted to a motor-car, the acid being allowed to drop in the exhaust of the car; and good results were obtained by the Tank Corps in this way. Fitted to a light car, however, results were poor; but experiments were carried on for some time with lorries. Although the method had not come into regular use before the end of the war, there were distinct possibilities in the idea. It was found that the best results were obtained under the following conditions:—

(*a*) That the pipe leading from the generator to the exhaust should enter the exhaust pipe at the point of maximum heat, *i.e.*, just below the outlet from the rear cylinder into the main exhaust pipe, care being taken not to allow the acid to drip or work through into the cylinder.

(*b*) That the exhaust should be fitted with a branch outlet for the smoke, thereby cutting out the silencer; or the silencer removed altogether.

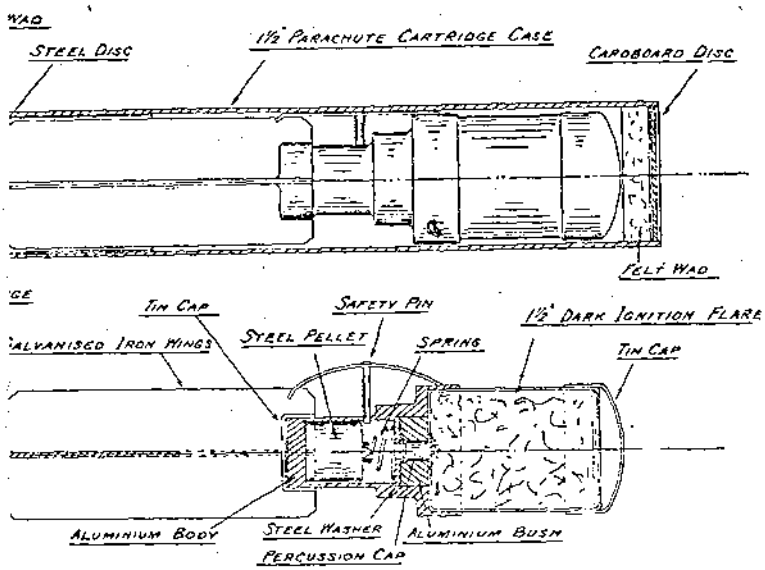
(*c*) That the moisture of the petrol vapour should be augmented by means of a water spray introduced into the pipe, and heated up so that if possible the water was condensed in the pipe.

Under these conditions a good smoke cloud was produced, and a drum containing about 10 gallons would last for half an hour. The acid had a tendency to choke the pipe, and it was necessary to run the engine until all the smoke died away, in order to clear the pipes.

The better results obtained by tanks were probably due, firstly to the higher power of the engine, and secondly to the fact that the engine itself would be running at full speed under a load. The tank, of course, need not necessarily be stationary to produce the smoke cloud, but a car or lorry engine would not be working under load

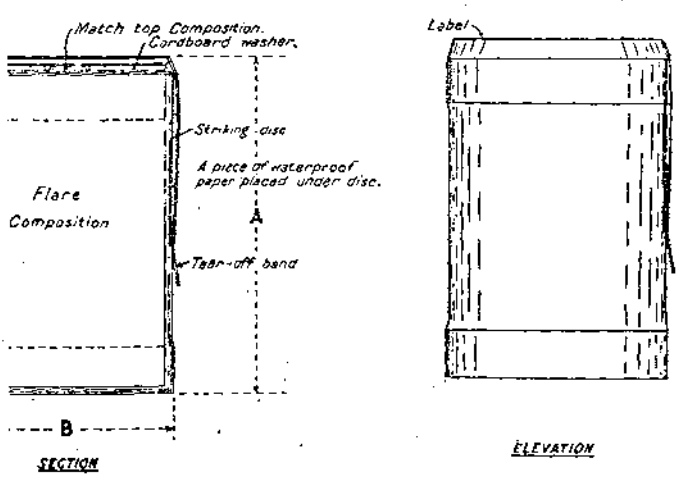
Fig. 1. PLATE X.

THE GRIFFIN PERCUSSION FLARE.



FLARES, GROUND, /L/.

TYPICAL



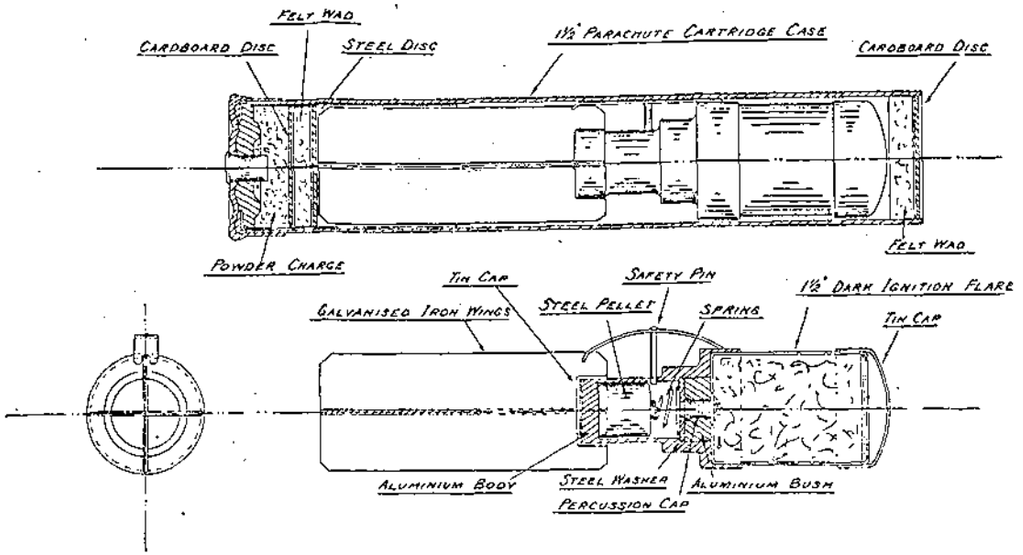
DIMENSIONS A	DIMENSIONS B	Mark	Colour of Flare
3"	2"	/	Red. Green, Yellow. White.
1¾"	2"	/	" "
1½"	2"	/	" "
1½"	1¾"	/	" "

Fig. 2.

PLATE X.

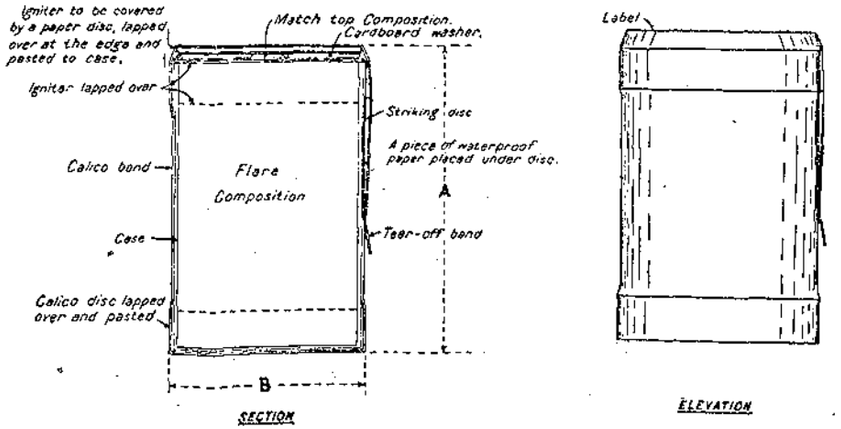
Fig. 1.

THE GRIFFIN PERCUSSION FLARE.



FLARES, GROUND, /L/.

TYPICAL

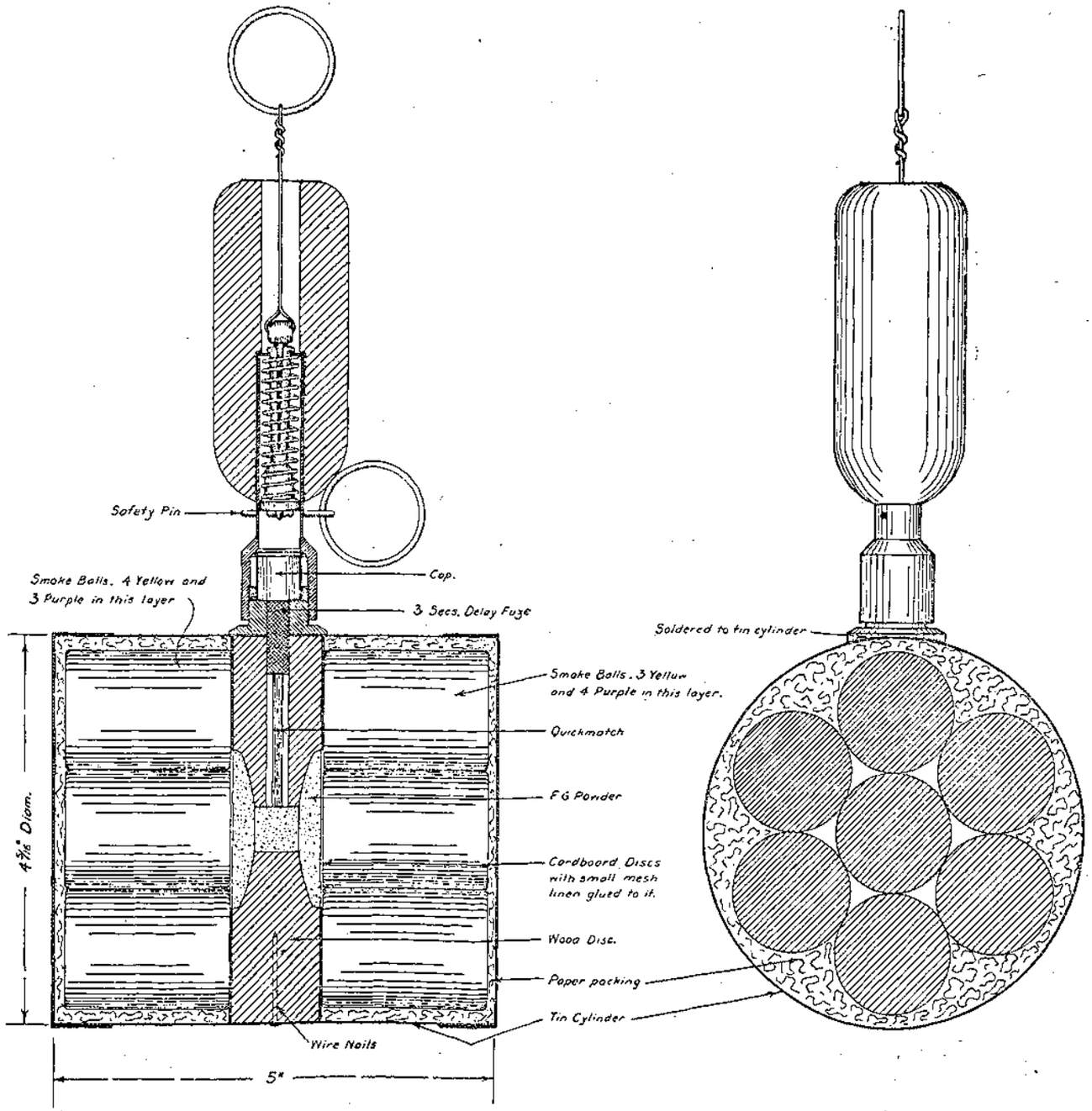


DIMENSIONS A	DIMENSIONS B	Mark	Colour of Flare
3"	2"	/	Red. Green, Yellow. White.
1¼"	2"	/	" "
1½"	2"	/	" "
1½"	1¼"	/	" "

Fig. 2.

PLATE XII.

R.A.F. PURPLE AND YELLOW SMOKE BALL INFANTRY CONTACT SIGNAL WITH SPECIAL R.A.F. IGNITER.

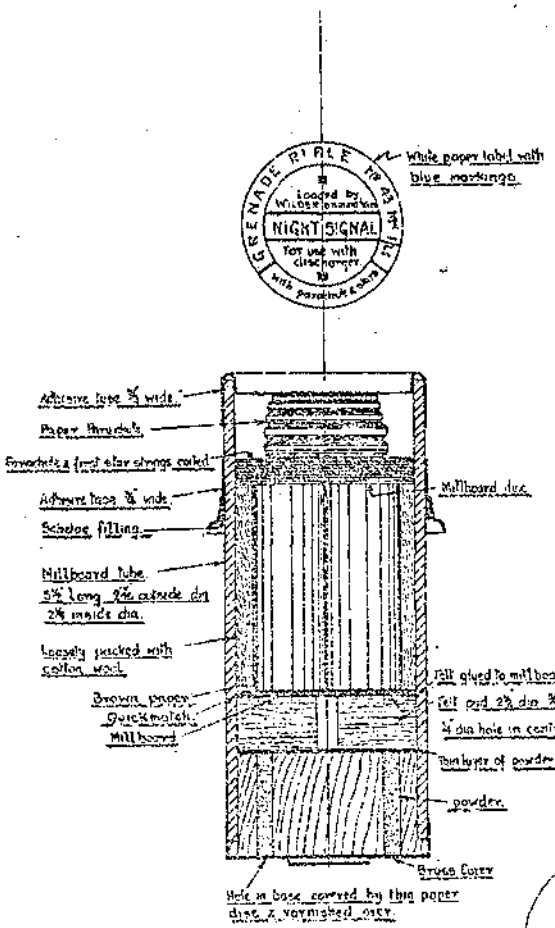


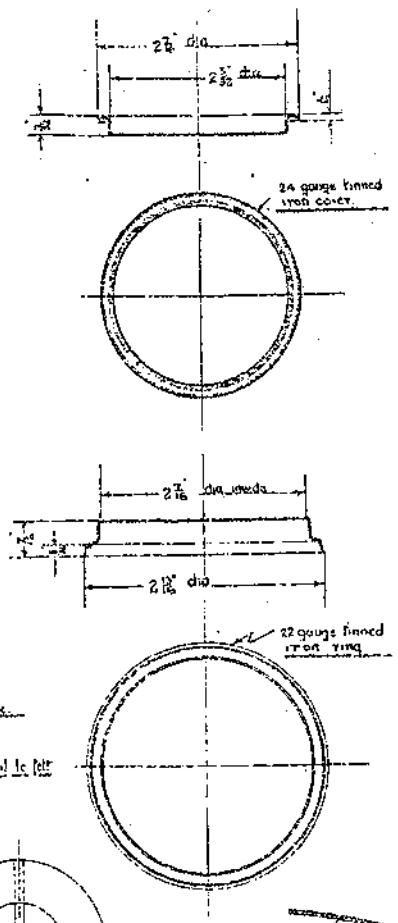
SECTION.

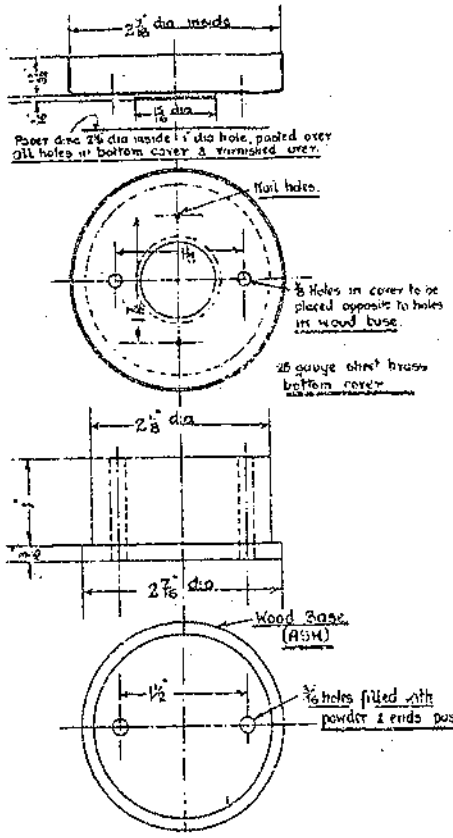
CROSS SECTION.

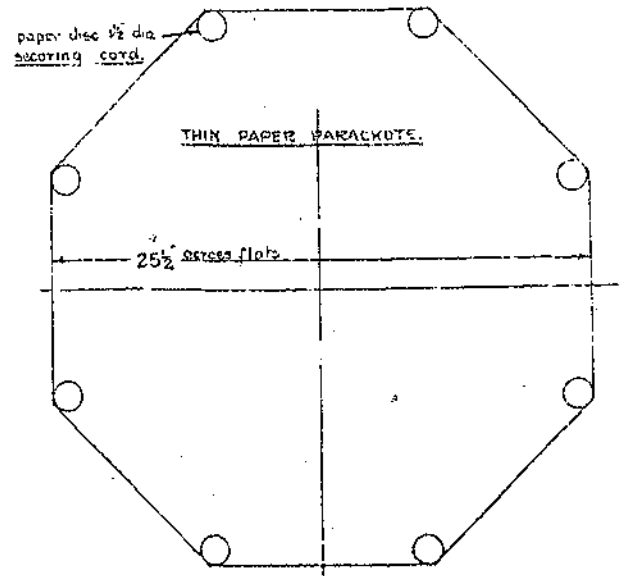
ARRANGEMENT AND DETAILS OF No 43–3 STAR PARACHUTE RIFLE DISCHARGER SIGNAL.

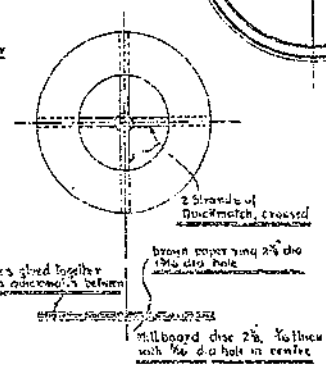
PLATE XI

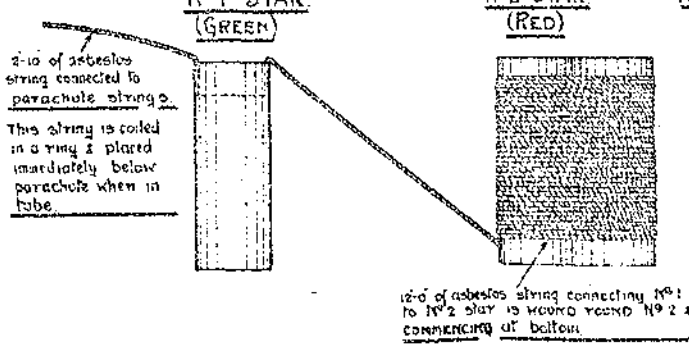












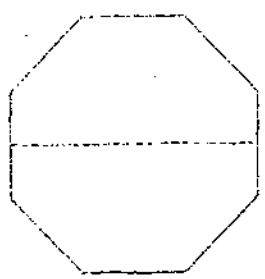


FIG 1.
Parachute laid flat

FIG 2.
Folded across centreline
Shewn dotted in Fig 1.

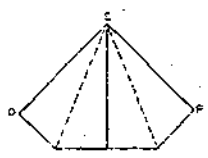


FIG 3.
Corners A & B. (Fig 2) folded forward until AC & BC become vertical.

FIG 4.
Corners DE & F (Fig 3) folded forward until CD & EF become vertical.

FIG 5.
Triangle GHJ (Fig 4) to be folded behind triangle GHK.

FIG 6.
Triangle LMN (Fig 5) folded across remaining portion.

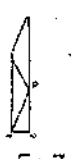


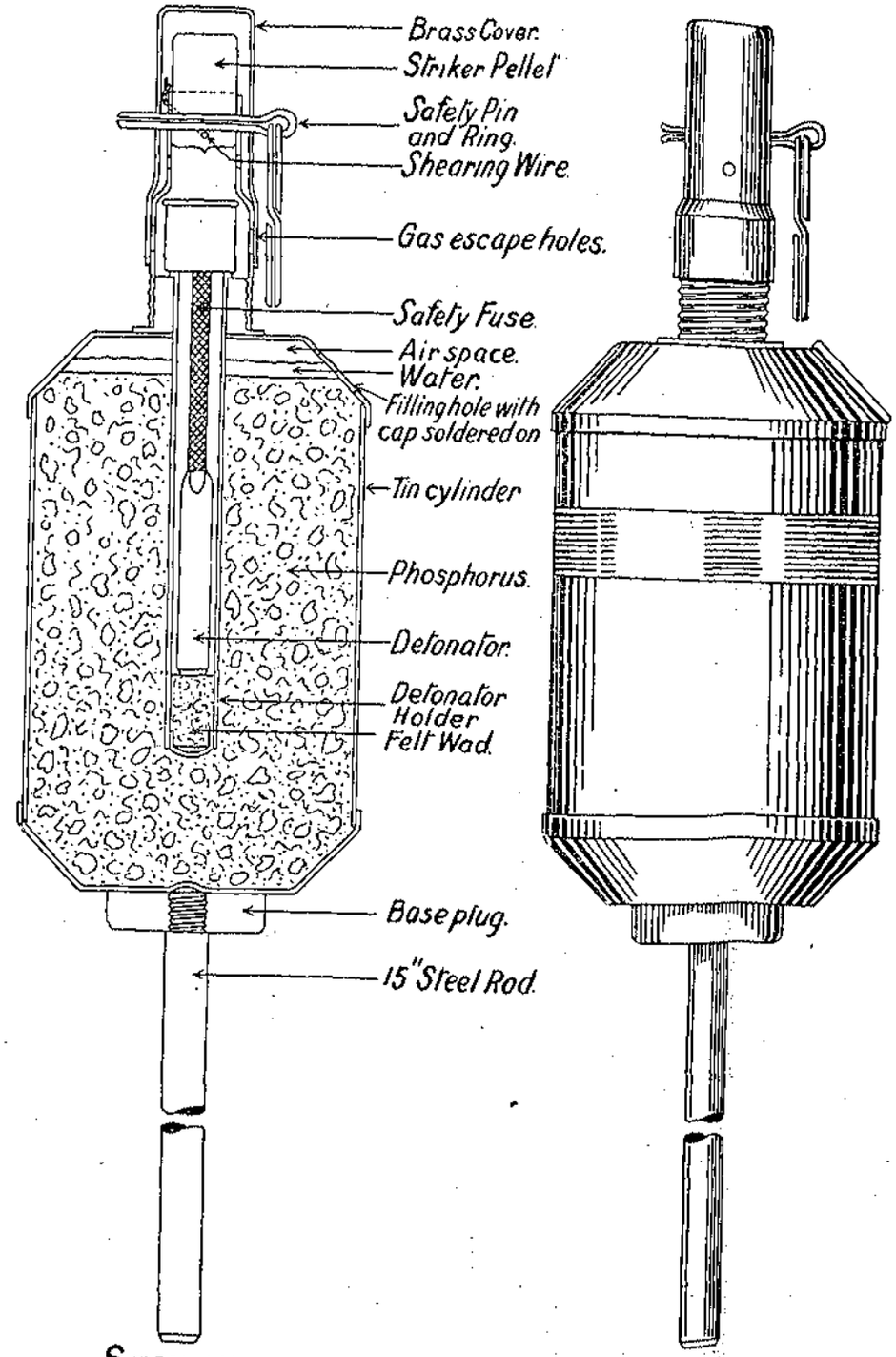
FIG 7.
Triangle OPQ (Fig 6) folded across front.

FIG 7. Folded forwards & backwards with apex at top. (Rectangle 1⅝ · 1½)

DIAGRAM SHEWING METHOD OF FOLDING PARACHUTE.

Fig. 1.

RIFLE SMOKE BOMB, No. 27.



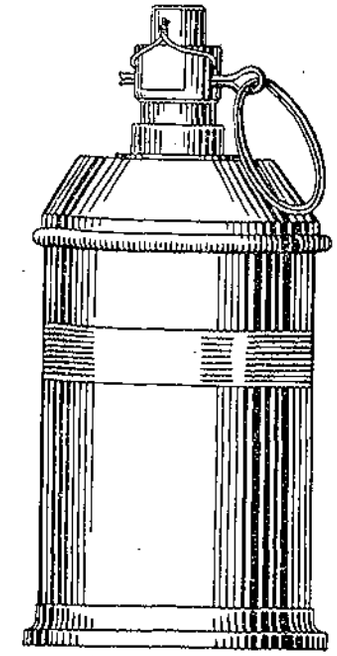
SECTION.

ELEVATION.

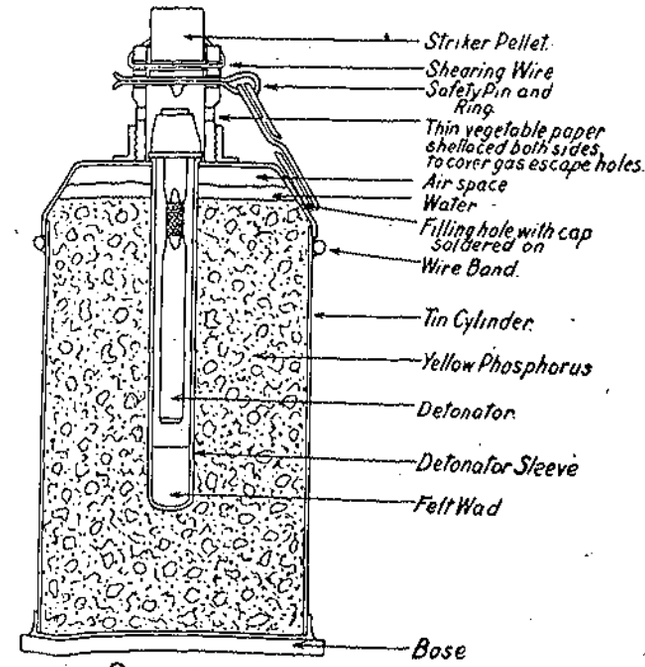
Fig. 2.

RIFLE SMOKE BOMB, No. 37.

FIRED FROM DISCHARGER CUP.



ELEVATION.



SECTION.

unless the vehicle was travelling at too fast a pace for the formation of a proper cloud.

Smoke Rifle Grenades.

The No. 27 smoke grenade was developed by the Experimental Section from an incendiary grenade used by the French. The French grenade was made of tin, and filled with yellow phosphorus; it was fired by a time fuze, with a "hit" mechanism, from which the idea of the "hit" mechanism of the Egg grenade was taken. Exhaustive experiment was carried out with this French phosphorus grenade, and finally resulted in the Nos. 27 and 37, which were manufactured in large quantities in England. Before the production of the No. 27, the "P" bomb had been converted to fire from the rifle, but was never satisfactory, being too heavy, and not constructed for that purpose. A good many, however, had been adapted, and various patterns of base for it were manufactured in army workshops.

It has already been mentioned that the original "P" bomb was filled with red phosphorus, which was not a good smoke-producing substance for use on ground over which infantry were to advance, as it remained burning on the ground for a long time, and would injure men who fell on it. In the improved patterns, both for hand and rifle use, yellow or white phosphorus was used.

Any form of phosphorus grenade had disadvantages when thrown by hand, for the phosphorus was always liable to be blown back by enemy artillery fire; and also the radius of spray on bursting was too great; with the No. 6 detonator the average radius was 20–25 yards, and in a wind, up to 30 yards, *i.e.*, practically the maximum distance of throw. After considerable experiment, the use of the No. 6 detonator was given up with these grenades, and the No. 3a commercial detonator introduced in its place, which considerably reduced the radius of burst. Trouble always existed with the firing mechanism in the field, because, when the grenade fell (especially when firing from the rifle) on hard ground, the whole mechanism was apt to be knocked off, carrying the detonator with it.

Similar trouble was experienced with the first supplies of the No. 37, which was the same grenade, adapted for firing from the discharger.

The final patterns of No. 27 and No. 37 smoke grenades are shown on *Plate* XIII.

SOME NOTES ON CENTRAL CANADA.

By MAJOR-GENERAL J. A. FERRIER, C.B., D.S.O.

CANADA is crying out for population, preferably of Anglo-Saxon descent, to occupy her vast unsettled territories, and promises immigrants a prosperous and healthy existence, assured livelihood, and a future of reasonable comfort to themselves in their old age and a career for their children.

It seems advisable to enquire into the present economic state of the country to ascertain whether Canada is really in a position to hold out these inducements to immigrants, which are undoubtedly made in good faith, and estimate for ourselves whether she is able to fulfil what she undertakes to do.

In the first place Canada holds out her invitation to people who are capable of engaging in agriculture and willing to go on the land. All others, though no doubt they would be made welcome, are not so desirable, from her point of view, for meeting her immediate needs.

It behoves us of the Old World to remember that the attitude of the men who have left the land of their birth to seek a world of wider expansion across the Atlantic, is one of hopefulness, not to say optimism.

The man who sets out to describe the whole of Canada is undertaking an impossible task. If he has devoted many years to travelling over the country, and has passed the four seasons in each district, he will find that the information first collected is ancient history, and conditions will have been rapidly changing while his investigation is still in progress. So, necessarily, a great deal of second-hand information has to be accepted and duly weighed by the light of what he has seen for himself. What follows is confined to what may be called Central Canada.

The Province of Ontario, comprising as it does within its borders the central seat of Government, naturally attracts a large proportion of the men who are in a position to express a reliable opinion on the conditions prevailing in the Dominion, as a whole: it has intimate connection racially and economically with the Province of Quebec, and Manitoba is not far off in the opposite direction.

The climates of Quebec and Manitoba are not altogether dissimilar in point of temperature. Both have very cold and long winters and hot summers. But Quebec has the inestimable advantage of a long riparian tract bordering on the shores of the St. Lawrence estuary: these districts have a somewhat less severe winter and the summer heat is tempered by sea breezes.

Southern Ontario, lying in between and bordering on the Great Lakes, has a considerably milder winter than its neighbouring provinces.

Northern Ontario, up away north of the Transcontinental Railway, and extending up to the Hudson's Bay, has little to choose in point of climate between itself and its neighbours.

It is unlikely that it will become a suitable area for permanent agricultural settlement for many years to come, though mining centres and lumber camps may be formed in certain localities when the development and population of the Dominion have so far advanced as to make the exploitation of the mining and lumber resources a paying proposition.

It is a great forest area, with a wealth of useful timber and inferior lumber suitable for conversion into pulp for the ever-increasing pulp wood industry.

The economic conservation of this store-house of wealth lies rather in its protection from forest fires than from the clearing of its timber for farm lands, and the Forest Department is already alive to the advantages to be gained from efficient patrolling and re-afforestation.

What is said above about the forests of Northern Ontario applies equally to those portions of Northern Quebec that afford the winter occupation of the farmers of the Province.

The French-Canadian has hitherto held the reputation of being the prince of lumbermen, and at Grand'Mère there is a model lumber organization that provides for re-afforestation and really scientific forestry.

A few words about Manitoba, the great prairie province with the flattering reputation of being an immense granary. Its capital, Winnipeg, may be said to be the clearing house of all the grain in the West as far as the Rocky Mountains.

This area is practically all prairie land. It has attracted a large number of farmers from the United States, and for many years its rate of production of wheat was prodigious. But latterly there has been a considerable falling off, and where many years ago farmers counted on 40 bushels to an acre they have now to content themselves with 18 or even 12 as an average.

An undoubted disadvantage of Canada is the severity and length of the winter season. Its duration may be taken to average six months: its severity may be gauged by the following figures taken from the tables published by the Dominion Meteorological Service, Toronto.

Average number of days zero (Fahrenheit), or below, for period 1916–1922 :—

Toronto	8	...	Southern Ontario.
London	11	...	
Ottawa	37	...	Eastern Ontario.
Haileybury	55	...	Ontario.
Winnipeg	69	...	Manitoba.

The highest and lowest temperatures recorded are :—

Toronto	103°	—26°
Haileybury ...	102°	—48°
Winnipeg	103°	—46°
Montreal	95°	—26°
Quebec	96°	—34°

There is no necessity to insist on the severity of the climate, and it will be readily understood that the housing problem is not quite so simple as what we are accustomed to in the British Isles and in Europe generally. The heating arrangements in particular call for special care, as the risk of frost-bite is not to be run with impunity, let alone the freezing of water pipes with attendant discomfort.

So housing, room for room, costs a good deal more than in this country, and the coal bill forms a considerable item in the family budget.

Canada has, according to the latest returns available, 39,384 miles of standard-gauge railway, or one mile to every 215 head of population. These lines are working to the full capacity for only part of the year, and in many districts the Canadian Pacific lines and the Canadian National Railway lines work practically side by side, an uneconomic arrangement that has no advantage in any way, as the traffic rates are under Government control. It is hoped that the Government may see its way to scrap many hundreds of miles of redundant railway and so save the annual deficit on the working of the State-owned system.

The busy season is after the harvest, when there is a steady stream of wheat traffic running eastward from Winnipeg and Toronto. Any wheat that there may be for export west of the Rockies naturally takes a westward course, and it is even said can be profitably brought through the Panama Canal to European markets.

When the Transcontinental Railway was pushed across the continent, some years ago, the scheme was for a ruling grade of ·6 per cent. westward from Winnipeg to Prince Rupert and ·4 per cent. eastward to the Quebec Bridge. The War intervened : the land has not been settled to the extent that was estimated, and so the corn traffic has not come up to expectation.

Recent developments in Quebec and Ontario Provinces have taken the form of trunk roads, and an enormous increase of industrial activity. This trunk road policy is extending over the prairie provinces, and takes the form of substituting for the gravel or water-bound macadam roads of pre-war days somewhat ambitious motor roads, 24 and 30 feet wide, surfaced with bitumen on a macadam base. The roads in the cities and townships are as a rule built of concrete with a surfacing of bitumen. Sidewalks in the cities,

which before the war were made of old sleepers, are now replaced by concrete slabs.

Whereas before the war Hamilton was looked upon as the Birmingham of Canada, and there were a certain number of factories at Peterboro', St. Catherine's, London and Kitchener in Ontario, and at Montreal in Quebec Province, we now find a large number of factories in Toronto and Ottawa.

The development appears to be mostly in machinery, lumber and pulp mills; there are also some textile and woollen mills: but a reference to a Trades Directory discloses a number of enterprises, more or less of small extent, that have sprung up in recent years.

Whether the whole of these industries are Canadian-owned and financed by Canadian capital is a question that could only be answered by close investigation. But many of the firms are representative of parent establishments in the United States, and have probably been established on United States capital, and are often managed by citizens of the United States. However, they afford employment to Canadian workmen.

Trade, they say, is bad, and the results at present are disappointing. But it is open to doubt if there is sufficient field in a sparsely populated country for such an industrial expansion.

The public buildings in cities like Montreal, Toronto, Winnipeg and Ottawa are very fine indeed, and strike the stranger as somewhat palatial, considering the population catered for. It has to be borne in mind, however, that if a building in Canada is expected to last it must be solid. The walls must be thick to keep out the cold in winter and to conserve the artificial heat. The foundations must be deep, and a basement is a necessity to accommodate furnaces, coal storage and other accessories: it is, moreover, a protection against damp and cold rising from the ground. If anything should happen to the water-circulation system there are no fireplaces or stoves to act as substitutes for the central heating. Wherever one goes one is confronted with this heating question, and there is very little doubt that it is one of the ruling factors in the future prosperity of the country.

Municipal services in the cities and towns are very efficient, and great stress is laid on sanitation.

Street lighting on the whole is much in advance of what we are accustomed to in Europe.

Electricity is comparatively cheap and it is used lavishly. Too lavishly, for already there is a cry for more sources of electrical supply. The demand is specially acute in Ontario, where the Hydro-Electric Commission of the Province is straining every nerve to supply the ever-increasing demands for power, light and heat. The latest proposal being to site the St. Lawrence River dam projected in connexion with the International Navigable Waterway in such a

way that the requisite head of water may be obtained for generating the electricity so badly needed by the province. All that Niagara and Chippewa can supply is already used up.

Ottawa is well situated as regards water power. The province of Quebec has the call on many rapid streams, and the prairie provinces are not squandering their power in industrial enterprise.

But, taken all round, Canada must in the near future utilize every possible source of water-power or else she must scrap her industrial ambitions and restrict her supply of electricity to what is needed to keep her population from freezing in winter.

The natural question is: why not use their own coal? So they do. But it is soft coal, and burns away too rapidly, and fills the sky with smoke when used in the furnaces, which are designed for anthracite. Moreover, the transport of the coal to Ontario is not a paying proposition. Coal from the Maritime provinces finds its way by water to Montreal, and the Quebec province is more or less provided from this source. But when it comes to transporting Alberta coal to Ontario, it is going the same way as the grain traffic, and so its supply is precarious and the freight charge high. So anthracite is brought from Pennsylvania and costs in Ontario from $17 to $17·50 a ton of 2,000 lbs., say £3 16s. 6d. to £4.

A modest household of 4 to 6 persons calculates on using with economy 12 tons in a winter for heating alone. Cooking is mostly by gas, even the circulating hot water is heated by a gas coil. Actually last winter some people in Ontario found it economical to burn Welsh anthracite at £4 10s. a short ton on account of its superior quality, but the supply is limited.

The coal strike in the United States of some years back is still a poignant memory in Central Canada, and the risk cannot be run again. The way out is the difficulty.

There are many other causes that tend to send up the cost of living. House rent in the cities is very high. This is due partly to the cost of building, but more especially to the price of sites.

We consider £1 10s. to £2 per foot-run of frontage, 150 feet deep, a pretty stiff price in this country for a country site—this compares with $70 to $90 per foot for the last lot in a new suburb, 90 feet deep.

Then taxation. These are the taxes on a seven-roomed house in the outskirts of Toronto:—

General tax	...	$109·72	Municipal tax	...	$19·13
School ...	...	$52·75	City tax ...	...	$23·32
		$162·47			$42·45

Total $204·92.

As the landlord pays the taxes, such a house could not be let under $75 a month, say £180 a year.

This scale of taxation appears to be more than a new country requiring development can stand. But high taxation means high rent, high cost of living, and consequently high wages, and so on in a vicious circle.

Now, food is not expensive in Canada. The prices compare very favourably with those in England. Meat is a good deal cheaper, but not quite so good; fish, dear and rather scarce; bread, slightly dearer; milk and butter, cheaper and exceptionally good. All the rest much the same as in England, except potatoes, which have to be bought in small quantities except in households with exceptional frost-proof storage.

A family man, unless exceptionally well off, expects to have his cooking done by his wife. Charwoman or washerwoman costs $2·50 and car fare per day. Both are supposed to have breakfast before they come, and the day's work ends at 5 p.m. Nevertheless, the dinner and two other meals may be reckoned as usual.

The domestic service problem is just as acute in Canada as elsewhere. Servants can be found, but they are expensive; so many people live in apartment houses, where service is provided, or else in hotels.

The average daily charge at hotels is $6 *per diem* for bed and breakfast. A modest lunch would cost $·75 and dinner $1·50.

Then why is the cost of living so high?

Canadians say that their standard of living is higher on the average than that obtaining in the Old Countries. This is no doubt true in a great measure; but can they afford it and still continue to progress?

The following figures may possibly throw some light on the subject. Extracted from the *Canadian Year Book*, latest edition:—

Public Finance.

Years.	Revenue per head.	Expenditure per head.
	$	$
1907	10·71	8·18
1913	22·41	14·89
1918	31·31	21·41
1922	42·60	38·76

Public Debt.

Balance sheet, March 31st, 1921—	
Gross Debt	$2,902,482,117
Available Assets ...	$561,603,133
Net Debt	$2,340,878,984
Balance sheet, 1922—	
Total Debt	$2,902,347,137
Assets	$480,211,336
Net Debt	$2,422,135,801

Liabilities.

Funded debt payable in		1918.	1922.
London	...	$362,703,312	$307,641,659
Canada	...	$881,528,614	$2,002,215,601
New York	...	$75,873,000	$110,934,000
Total	...	$1,320,104,926	$2,902,347,137

It must be borne in mind that the Dominion took over the Canadian National Railways some few years back. We learn from *The Times* that the net revenue shown for 1922 was $2,480,000 and that for 1923 is $20,127,000, but these balances are struck before providing for interest charges or the service for debt.

Few will be found to question the statement that Canada's future prosperity depends on the development of its agriculture, timber and mineral wealth.

There are, therefore, four great industries in the Dominion—farming, lumbering, hydro-electric enterprise and mining—the last-mentioned being largely dependent on the third. But the greatest of these is farming.

How is it that we find in the census returns of 1910 Ontario's rural population to have declined by some 52,000 in the previous ten years? It is a matter of common talk that the rising generation will not stay on the farms. Ten years ago it was a subject of general comment that the young men were not content to remain on the farms in the eastern provinces and in Ontario, but all wanted to trek to the Far West. Now the talk is that they prefer to come into the towns and seek for "white collar" jobs.

A review of the 108 towns and cities ranging from a population of 5,000 to over 500,000 shows a total of 3,482,000, nearly 3½ millions out of a population of 8½ millions, who are dwellers in towns. ' Surely too high a proportion for a nation whose wealth is mainly in agriculture.

Is it that agriculture does not pay? Or does it not furnish a sufficiently rapid return in dollars? Or is it that life in the towns is more attractive? Now, the farmer says: I cannot make a decent living out of my farm so long as this high taxation is in force.

The rate of wages fixed by the citizen finds its way into the country districts, and the workman insists on town rates of wages.

The dweller in the city is the man who prices and trades the farmer's grain, and the farmer comes off second best. Seventy-five cents a bushel of wheat of 60 lbs. very soon dwindles down when it costs 20 cents to put it in the elevator at Port Arthur.

Why must all the grain be handled and carried immediately after the harvest? It would pay the farmer better to wait for the winter snows and utilize his horses for hauling the grain in the winter as he

used to do before this frenzy for motor traction and expensive motor roads came into being.

On the other hand many farmers got rid of their horses and adopted machinery for all their farming operations. Now the fallacy of this wholesale scrapping of horses is beginning to be found out, and the horse is coming into his own again, and we hear more and more of mixed farming.

As a body, the farmers are against the extravagant development of the motor roads and are not in sympathy with the expansion and decoration of the cities, which they have neither the time nor the money to visit except under the compulsion of business necessity.

They argue that all this expense really falls on them, for it is incurred with borrowed money; hence increased taxation all round, which falls heaviest on them, as their industry is the mainstay of the country.

It seems there is a great deal of force in the farmers' argument.

The farmer has had three bad years: 1923 and 1922 have been good, but he had arrears to make up, and he has had to borrow money from the banks. So the bumper crops of last year had to pay their toll to the bank agent before the grain was stored in the elevator.

The farm worker most favoured by the spokesmen of the Dominion Government is the man with some agricultural training who hires himself out for a term to the established farmer with a view to learning local methods and conditions, so that he may make a success of a farm of his own as soon as he finds himself sufficiently well off to make a start.

The harvester may come from anywhere. Some 12,000 men went out from Great Britain in 1923. Many of these it was hoped would stay on the land and eventually become farmers. We learn from *The Times*, January 17th, 1924, "Between 7,000 and 8,000 settled down to work in the Dominion. About 2,000 left voluntarily to return home or to go to the United States, and 800 were sent back to England."

The writer happened to be crossing from Canada at the same time as some of these deportees, and had an opportunity of discussing their case with the official in charge. They were all men who had refused work that was offered to them. Of those who remained on in Canada, a large number went out to lumber camps and the Government found jobs for many in the cities, factories, etc. But there seems to have been some misconception as to the rate of pay and amount of employment to be expected on the farms.

The rate given was $4 a day and their keep for the harvesting, and $6 a day and keep for the threshing.

The harvesting lasts from 3 to 4 weeks on the average, and the

threshing may be put at 3 weeks, say 18 days—an average man had therefore a prospect of collecting—

24 days at $4	=	$96
18 days at $6	=	$108
Total ...		$204, say £46.

After that he had to find another job, to last him for the winter.

At lumbering a man could get a wage varying from $15 to $25 per month and keep, according to capacity and the nature of the work he was put to. A tradesman working at his trade would of course get the market rate. It so happened that in 1923 building went on till well into the second week in December, and painters and decorators were at work at their trades in Toronto, Montreal and Ottawa up to 15th December. This was exceptional, and, as a rule, building trades are laid off from about the third week in November, and earlier further west and north, except, of course, in British Columbia.

Considering the harvester as a prospective emigrant, his first consideration must be how he is to pass the winter. If he can secure a permanent job on a farm, well and good; if not, he must do as the harvesters did last year, take what he can get.

It is idle to generalize, for there are many grades of work to be considered. It may be accepted, however, that a sober, willing man will not be out of pocket when the end of April comes round and he can reasonably expect to get a job.

Here a word of caution is advisable to the man without a trade. In the open market he will find himself up against the "Dago"—a generic term for seemingly all races from the South and East of Europe who are not French, Scandinavian or of the Teutonic race—who will work for 25 cents an hour and thrive on it.

If he drifts westward of the Rockies he is confronted with the Japanese market gardener and the Chinese restaurant keeper, waiter, etc.

There is still room for all, and a pessimistic note is out of place where a serious worker is concerned: but if a man expects to fill his pockets without earning his wages, he had better have fallen overboard on the voyage out. If he is going to hold a job down in Canada he must work and work hard, without shirking, and if the hours per day are more than eight, which is usually the case in summer, he must not squeal, for he will get no sympathy.

THE CONCEALMENT OF FORWARD COMMUNICATIONS FROM THE AIR IN MOVING WARFARE.

By CAPTAIN AND BREVET MAJOR B. C. DENING, M.C., R.E.

THE construction of forward communications was, at all times during the war, one of the chief tasks of Field Companies. Whether we care to look back at the mobile operations of 1914, or the long period of siege warfare which followed, or the months of slow movement in 1918, whenever an advance was in contemplation, it is almost true to say that forward communications were the only concern of Divisional R.E.

As regards the *concealment* of forward communications from the air, by the end of the war, both the necessity for concealment, and the methods for obtaining it were pretty generally understood. It is true that immediately prior to Ludendorff's offensive on the Lys in 1918, bridges were prematurely thrown, and gave away the attack, and it is probable that the Allies made similar mistakes at different times. But, on the whole, after 1917, engineers can claim that where surprises were not effected, the fault did not lie in their failure to conceal their communications.

Looking at the problem to-day, it is well to remember that the majority of the advances of the Great War were made after long periods of preparation. Thus, there was considerably more time and material available than is likely to be the case in the earlier stages of the next war with which to ensure concealment of forward communications.

The manœuvres carried out this year by the 1st Division in the Farnham–Odiham area gave an interesting example of the type of demand likely to be made on Field Companies in the way of forward communications. The manœuvres were planned to test, amongst other matters, the question of concealment from the air. The following is a brief description of the first day's operations as far as concerns the subject under discussion :

"The manœuvres were carried out in typical English country, with some woods, large fields bounded by thick hedges, some deep overgrown lanes and open main roads. The Air Force opposed to 1st Division was given reasonable air superiority and forced by air umpires to work under conditions approximating to those of war. During the first day's operations, the 1st Division (Blue), deployed two Infantry Brigades against a weaker (Red) Force. The weather was fine with visibility excellent. The Red

Commander instructed his Air Force to locate the Reserve Infantry Brigade of the 1st Division and to determine upon which portion of the battlefield it was to be thrown in. During the early part of the day, the Reserve Brigade was concealed in woods on the right rear of the Divisional front. In the afternoon, the situation was such that it had to be moved up to relieve the left Brigade in line.

It thus had to move up and across the front. It left the cover of the wood, taking special measures to avoid being seen from the air. Battalions moved out one at a time, in single file, along the side of roads, without transport. This method of advance led to a very considerable extension of the brigade, and was very slow, the brigade taking close on three hours to pass a point. The advance might have been made more rapidly but for a river over which the crossing places were extremely limited. It is of interest to note that the move of this brigade was not detected by the enemy airmen, though the area was under continual observation."

Now it is clear that in war, the situation will rarely be such that we can allow an Infantry Brigade three hours to pass a point. During manœuvres, many fields are out of bounds, property has to be respected, hedges and fences cannot be cut and troops are forced to use only the existing roads and tracks. In war, steps would be taken to ensure that the reserve troops were sent up rapidly into line and yet remained undetected. Taking the situation of the 1st Division on the night preceding the operations just described, where such an advance is contemplated for the next day, it is certain that the C.R.E. would arrange for the marking and preparation of numerous tracks to the front, bridging, cutting, filling-in, etc., where necessary. With little chance of daylight reconnaissance, during the hours of one night, Field Company officers would be required to choose the line the new tracks were to take and carry out all necessary work. At dawn they would be required to follow up the advance and carry forward the tracks at the pace of the advance so that, at any time, reserves could be sent up without delay, concealed from air observation. It is in connection with this type of task that one wonders whether R.E. officers possess all obtainable knowledge regarding the concealment of communications from the air.

There is little doubt that the concealment of moving troops is becoming an art with which all officers—certainly R.E. officers—should be familiar. There are many factors affecting this question of concealment.

The first, and most obvious method of obtaining concealment from the air, is by the use of darkness. This method has its limitations. Darkness invariably slows up movement and can lead to confusion and loss of direction. Constant night work wears out troops and may result in loss of efficiency. At certain times of the

year, in many latitudes, the hours of darkness are very short. Furthermore, airmen claim to-day, that, with the latest patterns of flares, great tracts of country can be lit up for considerable periods, showing up objects on the ground quite clearly. While darkness will always be regarded as the principal method of obtaining concealment, and will be made use of whenever possible, occasions will constantly arise (as with 1st Division manœuvres), when it is necessary to move troops in forward areas, by day.

In contemplating movement by day, the most important factor is the nature of the country. If we are operating on a prairie or a desert, it is probably almost useless to hope for concealed movement of troops by day. If we are fighting in close English country, as the 1924 manœuvres have shown, it is possible to move a brigade of Infantry without detection. The nature of cover to be found in the theatre of war will govern very largely whether there is to be day movement or night movement of the army. Next in importance to the nature of the country is the seasonal factor. In most possible theatres of war there are seasons in which, according as the vegetation is in leaf or not, the question of concealment from the air becomes easy or difficult. The factor of season should always be considered before making plans for concealment. Hand in hand with the consideration of season goes that of weather. It is true that there are now few days in the year in Europe on which aeroplanes cannot fly, yet there are a great many days in the year in which aeroplanes can see little. Prior to the great German offensive in March, 1918, there was a long period of dull weather which assisted materially in hiding the German movements. Aeroplanes flying low, under clouds, are not only more exposed to fire, but have a more limited and fleeting view of objects on the ground. Statistics, week by week, of weather in the theatre of war, will become a necessary addition to the original intelligence with which the Army embarks on a campaign.

The art of concealing moving troops is in its absolute infancy. There are a hundred and one facts yet to be determined. Let us examine some of the questions we should like to have answered in connection with the factors already mentioned. For instance, in movement by night, how do troops best remain concealed if lit up by aeroplane flares? Is it best to lie down or to remain standing still, or can they keep moving? On what surfaces should tracks be sited in order to show up troops least under flares? What coverings to hats, transport, etc., show up least under flares? Possibly those different in colour to those least visible in sunlight. In movement by day, are troops less visible at dawn and dusk and if so, why, and for how long a period after sunrise and before sunset? In operations on Salisbury Plain this year the writer noticed that after a night of heavy dew, at sunrise, the tracks of even individual

men were distinctly visible *in grass* to an airman at 2,000 to 3,000 ft. Is this the case on all surfaces and, if not, what surfaces should be selected for tracks? Are troops equally visible by day on all surfaces? No! the difference in appearance of objects on tarmac and macadam surfaces, for instance, is remarkable. Which then are the preferable surfaces for day tracks? To what extent can shadow be utilized to hide movement? Troops under the dark shadow of woods and buildings are absolutely invisible from the air. Does this apply to a lesser extent to the lighter shadows cast by hills in the early morning and late evening? Where cross-country tracks cross water they are particularly liable to detection. Have we considered special arrangements such as the throwing of the bridges at the time of use only, or the selection of bridging sites likely to be (at any rate on one bank), in shadow at the contemplated time of crossing? Have we considered the effect of speed upon concealment? Are slow moving infantry more or less visible than fast-moving cavalry and tanks? Is the mechanical army of the future going to be easier to conceal on the move than the slower one of to-day? Is dust very visible from the air? If so, what are the best surfaces to counteract this? If the enemy knows where to look for your moving columns, his task is easier—but how much easier? Is this point vital or not? What is the effect of his height on the enemy airman's ability to see troops? Does it make a decisive difference keeping him at 20,000, 10,000 or even 5,000 ft. up?

What real difference do weather, clouds and the leaf on the trees make to the power of observation of the airman? Such, then, are some of the questions to which every officer in the Army should know the answer, just as he knows the range of a rifle or a field-gun.

How are we to set about determining the answer to these questions?

Were there an Army School of Intelligence, these matters would, no doubt, be tackled systematically and the lessons proclaimed to all. As it is, there are two Schools where the problems under discussion can be studied by R.E. officers, though it is not the duty of those Schools to specialize on this subject. These are the R.A.F. School of Army Co-operation at Old Sarum, and the R.A.F. School for Interpretation of Aeroplane Photography at Farnborough. Now that Army Orders provide that every officer shall fly, if there is need for him to do so, it is to be hoped that as many R.E. officers as possible will be sent to these schools to fly and to answer the questions that affect their work.

In war, Commanders of Formations will certainly rely on their Field Companies to find *concealed* forward communications for the movement of reserves. A reserve thrown into battle is absolutely wasted if its arrival has been previously detected. On Field Company officers will rest, therefore, a big responsibility. Are we equipped to take this on?

*MODERN ROAD CONSTRUCTION AND IMPROVEMENT ON THE NORTH-WEST FRONTIER OF INDIA.**

By MAJOR P. W. L. BROKE-SMITH, D.S.O., O.B.E., R.E.

GENERAL REMARKS.

ROAD construction and improvement on the N.W. Frontier of India constitutes an important and interesting branch of the practical engineering work of the R.E. officer in India.

In the N.W. Frontier Province and Baluchistan, which are the N.W. Frontier provinces, all building and road work, both civil and military, is carried out by the Military Engineer Services.

Engineering work on the N.W. Frontier has a fascination of its own, and affords great opportunities to the active and keen R.E. officer for the exercise of responsibility and resourcefulness. Invaluable experience and training for war are afforded, in tackling engineering problems under limitations imposed by time and varying climatic conditions, in handling indigenous, imported, or military labour, in the utilization of locally available or the most suitable imported materials, and in transportation, often under active service conditions and frequently under conditions closely akin thereto.

The road constructional work now normally carried out in peace time by the R.E. officer in other parts of the Indian Empire is as a rule comparatively limited in its scope, and it is on the N.W. Frontier that the greatest experience is to be had in this class of work, for military or quasi-military purposes. In addition to the actual road building, the work of the Frontier engineer, particularly in connection or in conjunction with new roads in border territory, includes the construction of perimeter hutted camps, fortified posts, and blockhouses along the roads, for the accommodation of the regular troops, tribal or semi-tribal Militia and Scouts, tribal Levies, Frontier Constabulary, and Police, which control and police the border country.

Prior to the introduction of mechanical transport into the Army in India in 1915, the metalled roads maintained on the N.W. Frontier, and a number of "fair weather" partially-metalled or unmetalled roads which had been constructed for cart traffic and were on the

* Including the substance of a lecture delivered at the School of Military Engineering, Chatham, on 21st February, 1924.

whole excellent for their purpose, were unsuitable for heavy mechanical transport traffic, although they could take occasional motor cars and the ubiquitous Ford van. Since 1916, the improvement of the existing metalled roads, and the metalling and improvement of important unmetalled roads, together with the construction of new roads in extension of the existing system, for strategical and administrative purposes, has been progressively undertaken in the N.W. Frontier Province. In Baluchistan but little has been done.

A particular object which has latterly been developed is to facilitate the control and administration of the border territory by the improvement and extension of the lateral communications parallel to the frontier, with fortified posts at intervals, in addition to the frontal roads running across the border up the principal pass routes. This phase of the work is exemplified by the recently built Central Waziristan road between the Derajât and the Tochi valley, and its continuation to the Kurram valley (Idak–Thall road), also by the Derajât Cis-Border road between Daraban and Ghazni Khel.

The principal road communications of the N.W. Frontier are shown on the appended map.

M.T. ROADS BUILT AND IMPROVED SINCE 1916.

The principal work done in improving the Frontier road system for mechanical transport purposes, including the work in hand in 1914, comprises :—

Frontal Roads Improved or Constructed.

(i)	Malakand road (Nowshera–Dargai–Chakdara)	Improvements and bridging.
(ii)	Khyber road (Peshawar–Jamrud–Landikotal–Landi Khana)	Improvements and bridging and construction.

[Double road through the Khyber pass beyond Jamrud. Includes construction of new sections S. road in replacement of old *nala* bed track.]

(iii)	Kurram road (Kohat–Thall–Parachinar)	Improvements and bridging.
(iv)	Tochi road (section Bannu–Miranshah)	Improvements and bridging.

[Includes new length of road through Shinkai section between Bannu and Idak.]

(v)	Bolan road (section Sibi–Rindli–Kolepur)	Improvements and bridging and construction.

[New road constructed Sibi–Rindli at lower end of Bolan Pass. Road Rindli–Kolepur re-opened and improved as an unmetalled, partially bridged road.]

Frontal Roads Partially Improved or Constructed.

(vi) Tochi road (section Miranshah–Datta Khel) — Improvements.

[Work stopped during Afghan War, 1919, and not resumed owing to subsequent relatively greater importance of other roads.]

(vii) Gomal road (Kaur–Murtaza–Khajuri Kach) — Improvements and bridging and construction.

Lateral Roads Improved or Constructed.

(viii) Peshawar–Shabkadr–Abazai road — Improvements and strengthening boat bridges.

(ix) Peshawar–Michni–Shabkadr road — Improvements and bridging.

(x) Landikotal–Kam Shilman–Loe Shilman road — Improvements and construction.

[New road Kam Shilman–Loe Shilman. Work closed down after Afghan War, 1919, nearly completed.]

(xi) Central Waziristan road (Kaur–Khirgi–Jandola–Sararogha–Razmak–Isha) — Construction.

[Bridging across main *nalas*, some metalling, etc., remain between Jandola and Razmak, to be done as and when finances permit.]

(xii) Jandola–Sarwakai road — Construction.

(xiii) Dera Ismail Khan–Tank–Kaur road — Improvements and bridging.

[Includes new section 4 m. long between D.I. Khan and Tank.]

Lateral Roads Partially Improved or Constructed.

(xiv) Idak–Spinwam–Thall road — Improvements and construction.
In hand.

(xv) Derajât Cis-Border road (Daraban–Kaur and Tank–Ghazni Khel) — Construction.

[Along administrative border between administered territory and the more independent tribal area.]
In hand.

Miscellaneous.

(xvi) Various miscellaneous improvements, including construction or reconstruction of a few bridges, have been carried out on certain other roads, which have not been systematically improved.

In Baluchistan, an unmetalled cart road has been built between Surkai Zangal and Kila Saifulla, to connect Loralai with the Zhob valley, and a pack road has been made over the Bogra Pass.

The principal improvements required to the old roads include, to the extent necessary on each road :—

(i) Metalling where unmetalled, thickening metalling (including providing proper soling foundations where non-existent or insufficient), and widening metalling, according to the standard required.

(ii) Widening roadway where too narrow, particularly at the sharp corners which are frequent on hill roads, such as the greater part of these roads are.

(iii) Improving blind or too sharply curved and graded corners in hill sections.

(iv) Provision of cross-banking or super-elevation on sharp curves, particularly in hill sections.

(v) Bridging over unbridged rivers or *nala* crossings, except over minor *nalas*, where causeways may be provided or retained if suitable for the standard, and reconstruction and strengthening of old bridges.

(vi) Improvement of cross drainage, and reconstruction of weak culverts, including widening roadway over culverts where necessary. [The necessity for adequate cross-drainage on hill roads in a country of torrential and spasmodic rainfall is generally learnt by bitter experience.]

(vii) Provision of additional retaining walls, and reconstruction of weak retaining walls.

(viii) Realignment in cases in which the old alignment traverses faulty terrain (*e.g.*, shale or clay cliffs), where the road is liable to be constantly blocked by débris, particularly after rain, or gradually disappears down the hill side.

In all, since 1916, some 370 miles of road have been improved to various standards, including a good deal of bridging, and about 200 miles of new road have been built. With the completion of the roads now in hand, these totals will be increased to approximately 400 and 260 miles.

The bridging work done includes 29 girder bridges averaging 300 ft. in length (usual length of spans, about 100 ft.), besides many arched bridges (principally with stone arches, but including brick and a few concrete arches), and bridges of reinforced concrete decking on steel joists.

The expenditure incurred on the above-mentioned projects works out at roughly, 30,000 rupees, or £2,000, per mile, for improvements, and 167,000 rupees, or, say, £11,000, per mile, for new construction, including bridging, on the average.

The costs, which have risen considerably since 1917, of course vary with the locality, the nature of the country, and the conditions

of work, and are considerably higher in trans-border than in cis-border areas. The recently current rates for new roads in Waziristan, for purposes of approximate estimating, are Class I, Rs. 1.9 lakhs (or £13,000) per mile, Class II, Rs. 1.6 lakhs (or £11,000), Class III, Rs. 1.3 lakhs (or £9,000); major bridges of girder type cost approximately Rs. 1,000 (or £67) per foot run.

Outstanding Items.

A good deal of further work remains to be done if the N.W. Frontier road system is to be made reasonably complete in through communications fit for mechanical transport. This is particularly the case in Baluchistan and the N.W. Frontier Province, the bulk of the roads in Baluchistan being below mechanical transport standards, and there being no direct communication between Baluchistan and the N.W. Frontier Province either by rail or road.

The resuscitation and improvement of the old Golra–Khushalgarh and Gombat–Attock roads would also greatly improve the rearward communications to the central portion of the N.W. Frontier Province and the lateral communications between the Kohat district and the north: the Kohat–Peshawar road passes through practically independent territory and is therefore liable to interruption, although, as a result of the settlement with the local tribesmen after the murder of Mrs. Ellis at Kohat in 1923, the conditions through the Kohat pass should be improved.

Railways.

In deciding the standards for individual roads, upon the basis of traffic requirements (tempered by financial considerations), regard is, of course, paid to the railway system, with which the road system should be co-ordinated.

With reference to the railway system, roads may be classified as under:—

(i) Roads in advance of railheads, and roads radiating out from railways.

(ii) Roads parallel or approximately parallel to neighbouring railway lines.

The provision or improvement of a railway line does not necessarily do away with the necessity for the provision or upkeep of a road parallel to it, although, according to the standard of the line and its capacity for traffic, the standard necessary for the parallel road may need modification. Thus the completion of the Khyber railway will do away with the normal necessity for the second motor road, which, however, should remain useful for animal transport and for mechanical transport in emergencies.

Consideration of the railway system of the N.W. Frontier of India

is beyond the scope of this paper. The existing lines are shown on the appended road map. Improvements (*e.g.*, conversion from narrow to broad gauge and doubling single lines) and extensions are carried out from time to time, as necessity dictates and financial considerations permit. Amongst the improvements and extensions carried out in recent years may be noted the conversion to broad-gauge of the Nowshera–Dargai line, the construction of the Khyber extension from Jamrud to Landi Khana, which is under completion, the construction of the narrow-gauge line from Kalabagh to Khirgi in S. Waziristan and Bannu in N. Waziristan, and the extension of the Quetta–Nushki railway to the Persian border.

Future items that suggest themselves are :—

(i) A railway bridge across the R. Indus gorge between Mari Indus and Kalabagh, to replace the present steam-ferry connection.

[A bridge of any sort over the R. Indus crossing between Darya Khan and Dera Ismail Khan is out of the question : the river course varies from year to year over a ten-mile width, and in recent years the continued existence of Dera Ismail Khan has become seriously imperilled.]

(ii) Conversion to broad gauge of existing narrow-gauge lines, according to requirements.

(iii) Permanent line from Tank to Dera Ismail Khan.

(iv) Direct railway communication between Baluchistan and the N.W. Frontier Province *via* Fort Sandeman.

ROAD STANDARDS AND SPECIFICATIONS.

The normal road standards now in use are described below. These are the usual Military standards ; the standards for Civil Frontier roads are generally similar.

Metalled or Un-metalled.	Class.	Standard for Traffic.	Description.
M.	I	Suitable for "Continuous" M.T. traffic	24' roadway, metalled 16' wide, fully bridged (*i.e.*, bridged except where traffic would not be impeded over causeways). [In special cases, *e.g.*, in cantonments, widths may be greater.]
M.	II	Suitable for "Intermittent" M.T. traffic	20' roadway metalled 12' wide, partially bridged (*i.e.*, bridged across perennial streams, and where traffic would be impeded across causeways for over 24 hours—causeways otherwise provided in lieu of bridges where practicable and cheaper).

Metalled or Unmetalled.	Class.	Standard for Traffic.	Description.
M.	III	Suitable for "Occasional" M.T. traffic	18′ roadway, metalled 9′ wide, unbridged except across perennial streams (causeways provided elsewhere in lieu of bridges, where practicable and cheaper).
U.	IV	Suitable for carts (and in certain cases for occasional light M.T. traffic, principally in dry weather only)	12′ roadway, unmetalled, unbridged except across perennial streams. (Surface may be shingled where soft.)
U.	V	Suitable for camel traffic	10′ roadway, unmetalled and unbridged (practically exclusively hill roads).
U.	VI	Suitable for pack mule traffic	8′ roadway, unmetalled and unbridged (practically exclusively hill roads).

NOTE.—These standards may be varied to suit particular local conditions. Bridging to be individually decided for each road. Essential culverts and small bridges (*e.g.*, for cross-drainage and where necessitated by the alignment) to be given in all cases.

In connection with the improvement and construction of roads for mechanical transport we are, of course, only concerned with the metalled standards, *i.e.*, Classes I to III. Unmetalled roads are now not usually constructed to any extent, except in certain areas where mechanical transport is not used (*e.g.*, Chitral), and as field service roads. In special cases, the initial provision of an unmetalled cart road (Class IV), fit in fine weather for occasional light mechanical transport, to be improved later, may be considered where it can be made to suffice and a metalled standard absolutely cannot be afforded: this is a cheap and nasty makeshift. In some localities, as in parts of Baluchistan, where the natural soil is of a hard gravelly nature, well-made unmetalled roads will take a surprising amount of light mechanical transport traffic, if well looked after.

It is laid down that the alignment, etc., of a Class II or III road shall be such that the road can be converted to a higher standard later if required: the alignment specified for a Class IV road is the same as for metalled roads, with the same object. This principle of convertibility is always valuable, and it is of particular importance in the case of these roads on account of the fact that for reasons of expense many of the roads have to be made to the cheapest possible practicable specification in the first instance.

The salient points of the present specifications for metalled roads are as follows :—

Gradients.—(i) Ruling—1 in 20. In long stretches of ruling gradient, flats 100′–200′ long to be given about every half mile.

(ii) Maximum—1 in 13, over distances not exceeding 300′. On sharp curves, gradient to be *nil* or very slight.

(iii) Maximum rise per mile—240′.

Radius of Curves.—Centre of roadway.

(i) Normal minimum—60′.

(ii) Minimum at hill zigzags—35′.

Super-elevation on Curves.—(i) Maximum, for radius 35′—1 in 7.

(ii) For radius 50′—1 in 10 ; 100′—1 in 20.

Inversely proportional to radius of curve.

Width of Roadway.—At formation level, excluding side drains and parapet walls.

(i) Normal width—Class I 24′, II 20′, III 18′.

(ii) Increased 2′ to 4′ on embankments and at sharp corners. Inner side at blind corners in hill sections cut down to give drivers clear view round corner.

(iii) Reduced 4′ to 2′ in straight hard rock cuttings.

Soling.—Except where unnecessary on rock or hard conglomerate.

(i) Normal width—1′ wider than metalling. Full roadway width on very soft formations.

(ii) Normal thickness—6″ to 9″. Increased where necessary on very soft formations.

Metalling.—(i) Normal width—Class I 16′, II 12′, III 9′. Widened 3′ to 4′ on sharp curves. Full width over bridges and culverts.

(ii) Normal thickness before consolidation—Class I 9″, II 6″, III 4½″. Ditto after consolidation—Class I 6″, II 4″, III 3″. Layers 4½″ to 6″ thick.

Camber.—Crown slopes, curved off.

(i) Normal—1 in 40.

(ii) On curves—super-elevation cross-slope.

Clear Width of Culverts. (Not over 12′ between abutments).

Clear roadway width. Humps in road to be avoided.

Clear Width of Scuppers. (Paved dips not over 20′ span across.)

Clear roadway width.

Scuppers used in lower standards in preference to culverts, where practicable and cheaper. Sharp dips in road to be avoided.

Clear Width of Bridges.—(i) Normal—Classes I and II 18′, III 10′. To facilitate subsequent improvement, arch bridges on Class III roads may be 18′ wide, and piers and abutments of other bridges may be as for 18′ width.

(ii) Small bridges on sharp curves may be up to 4′ wider.

Width of Causeways and Overflow Bridges.—Classes I and II—18′, III—12′.

Tunnels.—(i) Normal clear width—Classes I and II 18', III 12'.
(ii) Normal headway—
13' minimum over centre of roadway.
8' minimum over sides of roadway.

Sidings.—Normal size 66'×16' maximum width; outside edge on arc of 39' radius. Normally to be provided at watering places, at the tops of long inclines, and at each end of one-way traffic bridges, as ordered. On specially important M.T. roads, may be provided in hill sections at regular intervals (*e.g.*, every mile), alongside level stretches as far as possible.

Parking Places.—At termini and stages, as required.

Road Signs.—Mile and furlong stones, direction posts and place-name signs, warning signs and notices, road-name signs. For warning signs symbols similar to those laid down by the British Ministry of Transport are standardized.

Strength of Bridges and Culverts.—Calculated as for 12-ton steam-roller with 25% impact. Will take any train of loads in which no axle load exceeds 12 tons and no distributed or caterpillar load exceeds 18 tons, under due precautions as to intervals, speed, load on centre of road, and no other load alongside, in the case of the heavier loads.

These specifications have not been followed uniformly, owing to alterations and improvements made as experience has been gained and the requirements have developed.

The criterion adopted for the specifications is suitability for military mechanical transport lorry traffic at minimum cost. Roads built in accordance with them will take all the other classes of Indian military traffic, and equivalent civil traffic. The various standards are devised to suit the volumes of traffic which may be expected on such roads. Bridges constructed according to these specifications will take vehicles up to 10-ton tractors and 18-ton whippet tanks, with due precautions as to speed and intervals.

For financial and practical reasons, a better surface than water-bound macadam (on suitable soling) is not at present generally specified for Indian roads, except in certain of the most civilized cities and towns, and the Frontier metalled roads are so surfaced, a very good grade of limestone being generally available. There can be no doubt, however, that in the future more modern methods, such as the use of tar-spraying, tar macadam, or cement concrete, must be gradually introduced on the principal roads, if and when financial exigencies admit of the necessary comparatively heavy initial outlay. The tar treatment of roads is already in use in various large cities and cantonments in India, with varying degrees of success, experience in devising specifications suitable to the climatic conditions and to the available materials being progressively gained. Non-slippery surfaces, which are desirable in any case, are particularly important in the case of hill roads and of roads carrying a considerable proportion of animal transport; this factor has to be

taken into consideration in the specifications for surfacing, in addition to providing for the necessary firmness and durability under extremes of heat and cold.

Another direction in which the present standard of Indian roads generally is susceptible of improvement is in the abolition of the present usual limitation of the metalling to a central strip, the sides or berms of the roadway being unmetalled or merely gravelled and rolled. To effect this improvement to any appreciable extent, having regard to the large mileage involved, would, of course, involve an impracticable financial outlay. So, for the present at any rate, the disadvantages of dust and mud and limitation of wheeled traffic capacity, particularly in wet weather, must be put up with. It is, however, possible to mitigate the disadvantages by gravelling and rolling the berms, and by tar-spraying, as done on earthen roads in America. The disadvantages are, of course, less on minor roads, and also on hill roads, which the Indian Frontier roads largely are. In hill roads on the N.W. Frontier the berms, except in embankments, are frequently of a durable gravelly or rocky nature, and are usable by passing traffic more often than not, owing to the spasmodic and comparatively small rainfall.

A third special feature of the Indian Frontier roads, which, as mentioned above, are largely hill roads, is the mountain *nala* crossings which abound. These *nalas* usually have boulder and gravel beds, and are generally dry, or practically so, except for a small trickling stream, under which conditions wheeled traffic can cross them, the surface being suitably smoothed, or a paved causeway being provided in lieu of bridging, to save expense. But the intermittent spates to which these *nalas* are liable at uncertain intervals, and which are generally worst during the summer months between July and October, are liable to completely breach the roads for all traffic at all except minor *nala* crossings, unless they are bridged. Although a spate, which may be 6 ft. deep or more, may only last for a few hours, the remaking or clearing of the roadway for wheeled traffic is often a matter of days, particularly in remote places where labour is not rapidly obtainable; moreover even when an unbridged crossing has been so reopened, as likely as not, particularly during the spate season, it will be breached again the next day.

PHOTOGRAPHS.

A selection of photographs* is appended, to convey a general idea of the work and the surroundings. These photographs principally illustrate the Central Waziristan road, which has recently been completed in first essentials, and furnishes a notable example

* Included in a series of slides shown at the lecture at the S.M.E., on 21st February, 1924.

MODERN ROAD CONSTRUCTION AND IMPROVEMENT
ON THE NORTH-WEST FRONTIER OF INDIA.

Photo No. 1.

Photo No. 2.

NORTH WEST FRONTIER OF INDIA

Photo No. 3.

Photo No. 4.

PHOTO 3 and 4

of modern Frontier road work. The final sections of this road, *viz.*, Isha–Razmak from the Tochi end, and Sararogha–Razmak from the south, 41 and 24½ miles long, were built in 14 and 8 months respectively, a memorable achievement. (The latter was completed in first essentials only.)

The following notes deal with points of practical interest relevant to these photographs :—

No. 1. *Ali Masjid Gorge, Khyber Road,* 1920.—Showing the double road. Improved north road on the left, showing banking and widening at corners. New section of south road on the right. The bridging was hastily completed during the Afghan war in 1919 ; the constricted bridge approaches were subsequently improved.

No. 2. *Boat Bridge at Adozai, Peshawar–Shabkadr Road,* 1920.—An example of the old boat bridges which remain in some places. On important roads they are replaced by permanent structures, when funds permit. Note the special system of removable and adjustable trestles, devised to carry the superstructure in the cold weather low-water season, when this channel nearly dries up and the boats are aground.

No. 3. *Main Stream Kabul River Bridge at Michni, Peshawar–Michni Road,* 1920.—Six 100-ft. girder spans, on brick masonry piers and abutments, on well foundations with concrete core. Roadway carried on reinforced concrete decking, supported by cross-joists carried on the top booms of the girders. One of a pair of bridges, the other being of two 110-ft. and one 140-ft. girder spans, constructed across the two branches of the Kabul river at Michni in 1918–19. These bridges were built in conjunction with the Bridge Engineer N.W. Railway, under a system by which the Bridge Engineer undertook the provision and erection of all large bridge steelwork, using old railway girders made available by the remodelling of old railway bridges, with resultant efficiency and economy. In this case the Bridge Engineer was also responsible for the sinking of the well foundations in deep water by a specially devised method, the bridges being completed, except for decking, in five months. Under the system now in force for Frontier girder bridges, the Military Engineer Services are responsible for all erection work at site, the Bridge Engineer supplying the steelwork, remodelling the girders as necessary, and advising technically. The system of bridgehead protection by diagonally opposite block-houses may be noted. This type of bridge (steel girders on masonry piers, usually of stone), has hitherto been the normal type for all Frontier road major bridges in recent years, including the more common bridges across *nalas* in the hills, which are practically dry except when spates occur. The alternative use of pile bridges for the latter crossings, to reduce expense, has recently been under consideration. Suspension bridges have hitherto been but little used, but there should be a future for them on the Frontier hill roads if the security objection to this type in trans-border districts can be overcome. This latter factor, *viz.*, security of road structures against wilful damage by malcontent tribesmen or mischievous travellers, has to be reckoned with, and the simplest and sturdiest forms of structures must, therefore, preferably be used in

all cases. For the same reason, road signs (*e.g.*, mileage, danger signs, etc.), are frequently painted on large rocks.

No. 4. *Khirgi Camp, Kaur–Jandola Road, September*, 1922.—A typical view, showing a military camp and the entrance of a Frontier road into the hills of tribal territory. The kink in the road is due to the diversion of the road around an aeroplane landing-ground, which was selected after the road had been constructed. This is an example of the necessity for co-ordination and the exercise, by the roadmaker, of a high degree of imagination to provide for all possible contingencies in aligning a road.

No. 5. *View down Khirgi–Jandola Road, September*, 1922.—Showing the Lower Zam or Kiriwam Bridge and a typical stretch of trans-border country. These roads frequently have to be opened for traffic before completion, and the engineer has to proceed (with diversions where possible) whilst traffic is passing. This bridge had to be temporarily floored with sleepers, pending completion with steel troughing when the latter arrived from England. [Note the road post (blockhouse) on the hill on the left.]

No. 6. *Takki Zam Nala Bed Section, Kotkai–Sararogha Road*, 1922.—An example of a case in which the only practicable alignment through this difficult country lies alongside the *nala* for about half a mile, at the foot of precipitous high cliffs, the alternative being a more expensive detour, involving an increase in distance (an important matter from the staging convoy point of view), steep winding gradients, traffic protection difficulties, and greater expense. A similar case, near Kotkai, in which the conditions were worse owing to the sharply curving conformation of the *nala*, was ultimately solved by the provision of a tunnel through a hard conglomerate salient. In this latter case, the "engineering" alignment traversed a plateau, through a graveyard. The Mahsuds, however, would not agree to the road being built on this alignment, even on payment of the comparatively heavy compensation which is customary whenever a road alignment necessitates acquisition of cultivatable land, diversion of irrigation channels, displacement of graves, etc. So a deviation along the bank of a side *nala*, followed by a steep climb over a hill, joining the "engineering" or "true" alignment beyond, had to be adopted at much greater expense; the first portion of this deviation has recently been made permanent with the aid of the tunnel.

This latter furnishes an example of one of the special features of engineering work in trans-border areas or tribal territory, *viz.*, the subordination of engineering desiderata to political exigencies, when they conflict. The Frontier engineer must work in the closest co-operation with the political officer.

It is also a good example of the use of tunnels, which are not common on these roads.

No. 7. *Ahnai Tangi, Kotkai–Sararogha Road*, 1922.—An example of a Frontier gorge, where the torrent has forced a narrow opening through a fault in a solid rock formation. The floods through such gorges rise to 20 ft. or more. They come down very suddenly, and last only a few hours. In the absence of a made road, the *nalas* form

Photo No. 5.

Photo No. 6.

PICTURE 5 & 6

Photo No. 7.

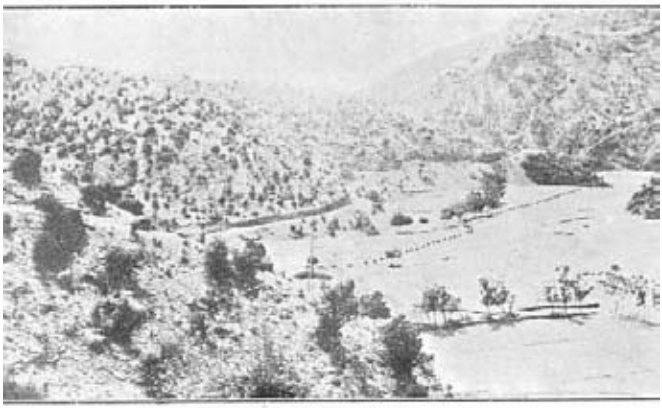


Photo No. 8.

PHOTO 7 and 8

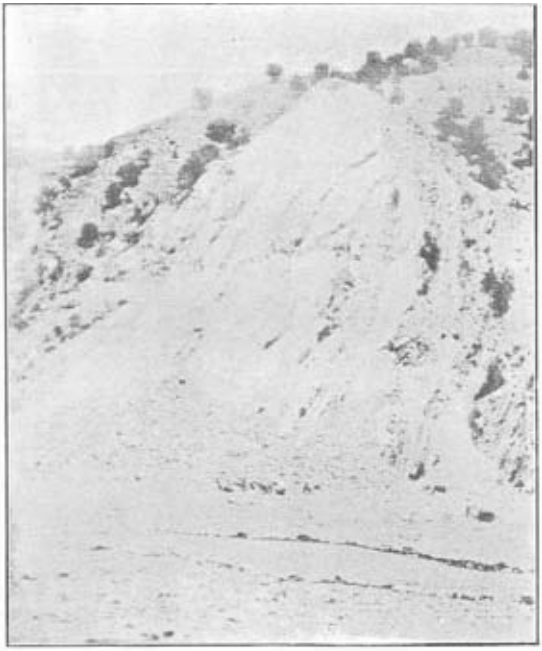


Photo No. 9.

Photo No. 10.

PHOTO 9 & 10

Photo No. 11.

Photo No. 12.

PHOTO 11 & 12

the usual highways in the hills. Troops and transport have been drowned in this gorge, before the road was made.

No. 8. *View down Sararogha–Razmak Road below Piazha, May*, 1923.—Showing road about two months after work commenced. (Note one of the camel convoys which transport supplies in the absence of a made road, and until the new road is fit for vehicular traffic.)

No. 9. *Rock-cutting near Aka Khel, Sararogha–Razmak Road, May*, 1923.—Showing Pioneers cutting out the road on a precipitous rock cliff. A great deal of the work on the final sections of the Central Waziristan road, between Sararogha and Isha, including all the difficult rock-cutting between Sararogha and Dwa Toi, was done by Sappers and Miners and Pioneers; it was evident that the road could not be completed in a reasonable time by the usual civil contract system alone.

No. 10. *Steam-roller en route across Takki Zam, Sararogha–Razmak Road, May*, 1923.—As soon as a section of new roadway is ready, steam-rollers are pushed forward in this manner; an easy forward section may often be ready for metalling before a difficult rearward section. The roller is being dragged by troops. Civilian labour, which has to be largely imported, will not come to or remain in a disturbed trans-border area in adequate quantities, particularly an area of hostilities such as Waziristan has been during the construction and improvement of roads therein, practically continuously since 1916.

No. 11. *Tal (Tochi) Causeway, Isha-Razmak Road*, 1923.—Showing the temporary causeway, constructed for use pending the building of a bridge, submerged and impassable for wheeled traffic. This illustrates the futility of causeways on main *nala* crossings, when permanent road communication is required. A girder bridge of six 110-ft. girder spans has now been completed here.

No. 12. *Razmak–Narai Ascent, Isha-Razmak Road, February*, 1923.—Showing military labour at work in the snow, clearing the road alignment. A fine road has been made up this difficult precipitous ascent, which is over 1,000 ft. high, from the Khaisora valley above Razani on to the Razmak plateau, on which Razmak, dominating the heart of Waziristan, is situated. The alignment winds up the hillside, with gentle gradients, wide corners, etc., according to the specifications, the rise being reduced to the maximum permissible rise of 240 ft. per mile. In contradistinction to the excessive heat of the summer months in the areas where the bulk of the road work is carried out in the N.W. Frontier Province, the winter at this high altitude (Razmak plateau is some 8,000 ft. above sea-level) is severe. When Razmak was occupied in the winter of 1922–23, a camel road was run up this Razmak–Narai ascent in the first instance, to permit of the maintenance of the troops at Razmak pending the completion of the mechanical transport road. The Isha–Razmak road was progressively opened to mechanical transport traffic by stages as soon as they were completed in first essentials, and the pack transport stages, in advance of the mechanical transport, were correspondingly reduced. Alternative camel tracks were also made over the passes between the Tochi and the Khaisora, for use pending the completion of the road for the full volume of M.T. traffic, and the abolition of pack transport on the line.

THE SENIOR OFFICERS' SCHOOL.

By MAJOR AND BREVET LIEUT.-COLONEL A. C. DOBSON, D.S.O., R.E.

THE objects of the Senior Officers' School are laid down in *K.R.*, 1923, paras. 815–816. They are :—

1. To disseminate and inculcate sound tactical principles as laid down in the official manuals, thereby ensuring uniformity of method in their application throughout the Army.

2. To give Senior Officers of all arms an opportunity of exchanging ideas as to the most approved and up-to-date methods in all matters connected with the training and administration of units.

3. To give higher tactical training to Senior Regimental Officers of all arms and assist them to train and administer a battalion or equivalent unit, according to the arm of the service to which they belong.

4. To report on officers as regards their ability to conduct the training and administration of a battalion or equivalent unit.

All combatant officers below the rank of substantive Lieut.-Colonel are required to undergo a course at the School before they can be considered for promotion to higher substantive rank.

Before an officer can undergo the course he must have :—

1. Reached the substantive rank of Major.

2. Served a continuous period of six months with his unit during two years immediately prior to his attendance at the School.

3. Been recommended for promotion in his annual confidential report.

Conditions 1 and 3 are invariably complied with, but circumstances may often, in the case of R.E. officers, prevent condition 2 being fulfilled, as many R.E. officers approaching their promotion to Lieut.-Colonel have been in civil employ and away from military duties for some considerable time when their turn to attend the S.O.S. Course comes round, and often cannot be spared from their jobs to do the qualifying six months with a unit of the Corps.

These notes have been compiled in the hope that they may be useful to such officers.

The School is situated at Sheerness in the old R.A. Barracks.

The telegraphic address is " Senos, Sheerness."

Telephone number : Sheerness 41 Military.

The Directing Staff consists of a Commandant, a Chief Instructor, a Cavalry Instructor, an Artillery Instructor, two Instructors in administrative duties (" A " and " Q "), three Infantry Instructors, and an Adjutant and Q.M.

The three Infantry Instructors also act as Leaders of the three

"syndicates" (consisting of officers of all arms), into which each batch of students is organized.

ACCOMMODATION.—A single field officer's furnished quarter is allotted to each student; these are either converted barrack rooms or adapted married quarters.

The barrack rooms are delightful in summer and nearer the Mess than the married quarters. On the other hand they are not so cosy as the married quarters in winter, and are further away from the Lecture Hall and offices. Blankets, sheets, pillow-slips and towels should be taken.

There are two hotels in Sheerness where married officers can obtain accommodation for their wives and families, *viz.*:—

The "Royal Fountain" in Blue Town, and the "Royal" in Broadway.

Both are within a few minutes' walk of the School.

A list of furnished apartments can be obtained from the Adjutant on application. Houses are practically unobtainable.

To obtain the best value from the course, officers are strongly advised to live in the Mess; as it is after dinner when yarns are being told and "lies swapped" that the best opportunities arise of exchanging ideas in friendly discussion.

Motor cars or motor cycles are essential, as practically all tactical schemes are carried out on the mainland, a distance of over ten miles in each direction. Garage accommodation is provided at the school for forty cars at a rental of 10s. per month. This covers the use of water for washing cars, electric light, etc.

BOOKS.—It has been laid down by the C.I.G.S. that the type of war we have to train for is mobile warfare against an enemy equally as well armed as ourselves. The only books that officers are required to bring with them to the School are:—

F.S. Regulations, Vols. I and II.; *Infantry Training*, Vols. I and II; *Cavalry Training*, Vol. II (*War*); *Artillery Training*, Vol. III (*War*); *King's Regulations*; *Manual of Military Law*.

In addition to the foregoing the following manuals are useful and officers are recommended to obtain them and read them before joining:—

Engineer Training; *Machine-Gun Training*; *Tank Training*; *Educational Training*; *Training and Manœuvre Regulations*; *Manual of Movement*: *Manual of Map-Reading and Field Sketching*: *Manual of Smoke*; *Manual of Field Works* (*All Arms*).

The following two pamphlets, published by the G.S. War Office, are also useful:—

Notes on Elementary Tactical Training; *Section Leading in Attack and Defence*.

It will be seen from the foregoing list that only official books and

regulations should be studied. Unofficial publications are viewed with disfavour, but the following two may be recommended :—

Notes on Infantry Tactics and Training, by the late Lieut.-General Sir G. M. Harper, K.C.B., D.S.O.; and

Military Organization and Administration, by Major W. G. Lindsell, D.S.O., O.B.E., R.A. (Gale & Polden).

The latter contains in a handy form a vast amount of information which is scattered throughout a number of official publications and has the advantage (at present) of being right up to date.

The course lasts twelve weeks and consists of lectures both by the Staff and outside Lecturers, discussions, tactical schemes (both outdoor and indoor), and visits to outside units, *e.g.*, the Artillery School at Larkhill, the M.G. School at Netheravon, etc., etc.

In addition to the solution of tactical problems (which are carried out in small groups of three or four officers) students are also required to prepare two or three tactical schemes embodying simple problems suitable for setting to junior officers and to N.C.O.'s of their own arm. They are also required to write a Memorandum on training their own unit. These two latter are carried out individually and not by "groups."

Students are also invited to give a lecture on any subject of military interest, but unless the lecture is a really good one and the lecturer absolutely "question proof" this is better not attempted.

DRESS.—The following is the order of dress worn at the School :—

(*a*). *Morning Lectures*.—Service dress; riding breeches. Belts need not be worn.

Note.—Belts will be worn by officers living out of barracks when proceeding to and from their residences.

(*b*). *Afternoon or Evening Lectures*.—Plain clothes, unless otherwise ordered.

(*c*). *Outdoor Work*.—Plain clothes, unless otherwise ordered.

(*d*). *Visits to Outside Units*.—Service dress; breeches and Sam Browne belt.

(*e*). *Mess*.—Mess Kit. Officers not in possession of Mess kit will wear evening dress coat. Dinner jacket may be worn on Saturdays. Supper on Sundays—any kit may be worn.

GAMES, LEAVE, ETC.—There are excellent tennis courts within a few minutes' walk of the School at Well Marsh, a racquet court exists in the Barracks; it is at present used for badminton, but a proposal has been made to convert it to a "squash" court.

The Sheerness Golf Course (9 holes) is within two miles of the School. Officers can become full members for the period of the course on payment of a subscription of £1 11s. 6d., which is collected through the Mess bill.

Leave from the end of the week's studies until Monday morning, 11.30 a.m., may be taken without application.

HISTORY OF THE 12th COMPANY ROYAL ENGINEERS.

(Continued.)

By LIEUT. M. R. CALDWELL, R.E.

CHAPTER IV.

Mobilization.—At 6.45 p.m. on August 4th, 1914, a telegram was received from "Commandeth, Dublin" ordering mobilization, whereupon everything became activity! All went smoothly and the Company was complete a day ahead of its schedule time, parading fully mobilized on August 11th, three additional officers and some 70 reservists having joined.

Personnel.—The strength of the Company was now 6 officers and 211 other ranks, the officers being Major A. F. Sargeaunt in command, Captain T. T. Grove, Lieuts. R. A. Turner, and W. F. Hanna and 2nd Lieuts. I. S. O. Playfair and A. M. Jackson. C.S.M. J. Redmore was the Company Serjeant Major; C.Q.M.S. Hobbs, Farrier Staff Serjt. T. Dawson and Serjt. Lukehurst were the senior mounted N.C.O.'s; and Serjts. Haggertay, Cahill, Fern and Park, Nos. 1, 2, 3 and 4 Section Serjeants respectively.

The Company left Moore Park for Queenstown on August 19th and, embarking on the S.S. *Maidan* on the 21st, sailed at 4 p.m. that day.

Cambridge.—The next morning found them, much to their chagrin, arriving at Liverpool, whence they proceeded into camp at Cambridge with the remainder of the 6th Division. Training with Brigades was then carried out until September 7th, when the Company marched to Royston (moving off within 20 minutes of receiving orders) and entrained for Southampton, where they arrived at 2.30 a.m. on the 8th and embarked on S.S. *Oxonian*, which sailed the same day.

France.—On September 10th the *Oxonian* arrived at St. Nazaire, and at 1000 hours the Company disembarked and proceeded to camp at Grand Marais.

On the 11th they entrained at St. Nazaire for an unknown destination and detrained the next day at Marles, near Coulommiers, whence they marched in a downpour of rain through the forbidding Forest of Crécy to Ferme de Bessy, about nine miles. The cyclists of No. 1 section were sent on ahead as an advanced guard, as it was thought that small parties of the enemy might be about, having been left behind by our own troops in their advance of a week previously.

No enemy were met, however, and the Company went into their first billets in the theatre of war at Ferme de Bessy in the best of spirits in spite of the rain.

On the 13th the Company marched to Jouarre (13 miles) where No. 1 Section, under Lieut. Turner, was put on outpost duty as infantry, while the remainder billeted in a convent. Nothing occurred during the night, however, and the next day, the pontoons having been sent to the 38th Company, the march was continued to Saacy, and on the 15th the Company marched with the Main Guard of the 6th Division *via* Château Thierry to Rocourt, a distance of 23 miles, where, after another march in the pouring rain, they bivouacked in a ploughed field at 11 p.m.!

The 6th Division was to have supported an attack by the 1st Corps on the Chemin des Dames, and the Company accordingly marched at 0600 hours on the 16th with the 16th Infantry Brigade to Buzancy, five miles south of Soissons, where they bivouacked just east of the village. (See *Map* II.)

In the afternoon Captain T. T. Grove made a reconnaissance of the ground between Billy and Belleu with a view to the construction of a defensive line.

At this time it was found that, as many units had lost equipment in the recent retreat, tools for parties working on the construction of the trench systems, which were now just beginning to become a prominent feature of the war, were getting very short. Accordingly, Lieuts. Turner, Playfair and Jackson were sent out with parties to requisition picks and shovels from the inhabitants in Rozières, Septmonts and Noyant, as a result of which 140 shovels and 30 picks were sent to the 4th Division Headquarters at Serches, the G.O.C. 16th Infantry Brigade expressing his satisfaction at the numbers collected.

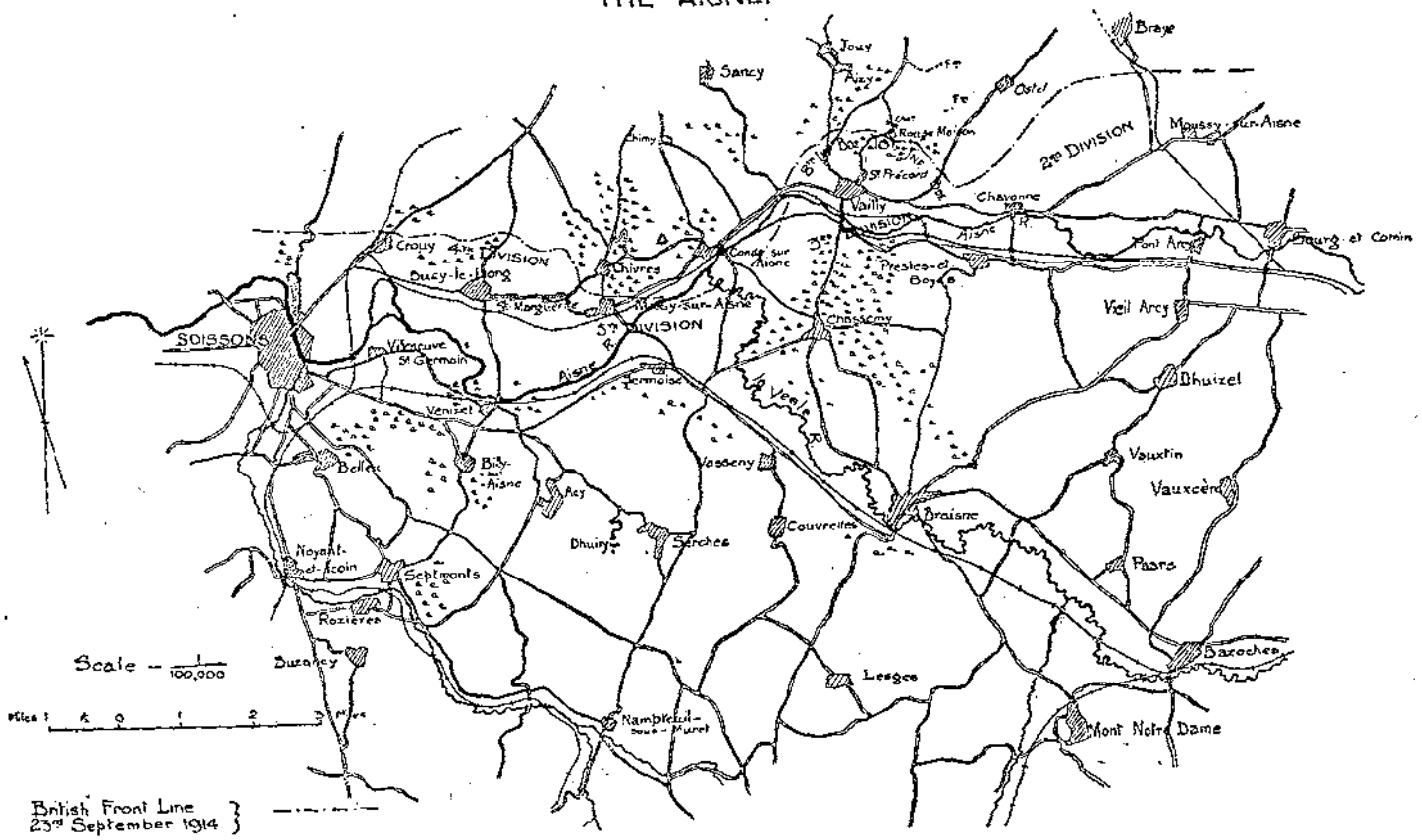
During the next two days reconnaissances of the proposed defensive line about Venizel and Villeneuve were carried out and barbed wire for obstacles was collected

On the 19th orders were received that the 12th Company was to remain with the III Corps to prepare positions in the neighbourhood of Belleu and Acy. The bivouac was then moved to Septmonts and the next day work was begun with the Royal Welch Fusiliers on the trenches in the new positon.

On the 21st the Company was ordered to Bazoches, 12 miles distant, and on arrival there was told to proceed to Mont Notre Dame, a further three miles, where further orders were received to go on to Paars, on the march to which place they were met by a Staff Officer and ordered to return to Mont Notre Dame to build a ramp for detraining 6-in. howitzers. This was finished on the 22nd, and was about 30 yards long, consisting of a crib-work of sleepers dogged and spiked together, with rails spanning between, and decked with 2-in. planking.

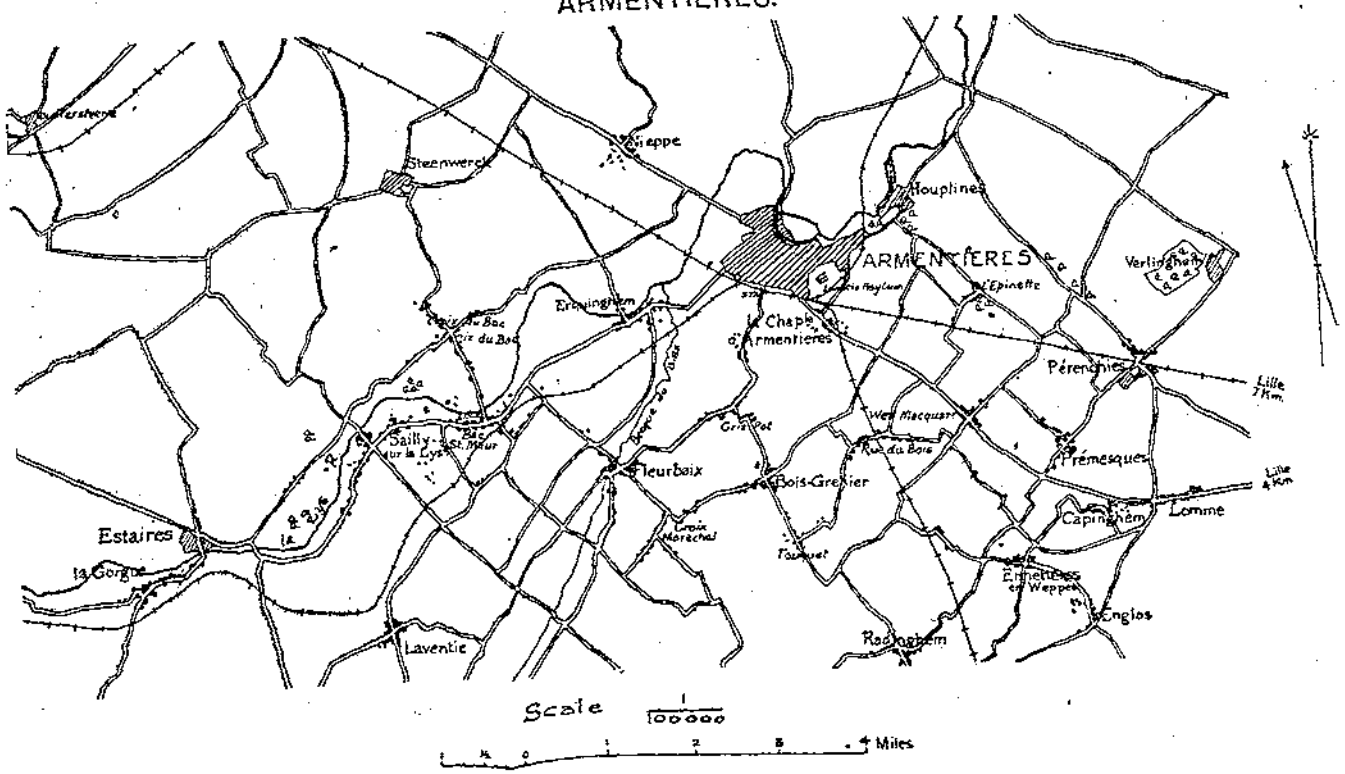
Map II.

THE AISNE.



Map III.

ARMENTIERES.



Company's bivouac on the march up to Soissons; made of planks, but with no nails!

Blanche Maison, Steenwerck and Croix du Bac to Bac St. Maur (see *Map* III), where the 1st Battalion Leicestershire Regiment were held up by the River Lys.

There was a swing-bridge at this point which the Germans had left open but had not destroyed. As it was worked from the far bank, Pioneer Dunford of No. 4 Section swam across with a cable, climbed up the central pier, and made it fast to an extremity, after which the bridge was pulled to. The Infantry then advanced and reconnaissances were made for the defence of the bridge.

On the 17th the Company marched with the 24th Brigade R.F.A. and billeted at La Vesée, work being begun at once on defences of all kinds in the sector of the 16th Infantry Brigade.

Very heavy fighting was at this time taking place round Premesques, Radingham and Pérenchies, during which reconnaissances were made and defence works carried out, usually under very heavy fire.

On the 20th the British fell back before the heavy German attacks, and after digging hard at Wez Macquart, the Company were ordered to move back and prepare positions during the night for the 16th Brigade about half-way back along the road to Armentières, where, in spite of the impossibility of sighting the trenches, owing to the darkness, work was begun at once. For a very long time after this these trenches remained the British front line in this sector.

Trench work was now begun in earnest, and the Field Companies settled down to what was probably the most trying period of the war for the Royal Engineers. Nearly all the trenches were in short, disconnected lengths; supplies were exceedingly short, there were only two Field Companies to a Division, and, in addition to collecting and preparing material by day for erection as defences by night, the Sappers were called upon many times to man the trenches.

On the 24th billets were moved to Fleurbaix.

The Company continued working all day and most of the night on trenches, wiring, barricades and rear defence lines. About the end of the month the scheme of making up wire entanglements in "sets" before erecting was introduced, thus lessening the time and labour necessary for actual erection in the front line.

On November 2nd the Company relieved the 20th Company R.E., in work on the rear line. Large civilian gangs were employed on this work under the supervision of a few N.C.O.'s and Sappers. Working under their own foremen (*chefs d'équipe*) and with their own extraordinary tools, they were able to excavate far more than could our own Sappers with G.S. shovels! These gangs, under one N.C.O. and two Sappers, undertook the whole construction and revetment of a complete second-line breastwork.

As the Company's billet was beginning to receive an unpleasant amount of attention from the enemy, it was moved to a farm on the

Rue de La Lys, near Erquingham, where workshops were started and the system of having two "forward sections" was instituted, the forward billet being in Bois Grenier.

About this time experiments with rifle grenades and trench mortars were carried out, and large quantities of hurdles, trenchboards, fascines, etc., were constructed in the workshops in back billets.

Inspection by Lord Roberts.—On November 12th the Company paraded and were inspected, on the occasion of a visit to their billets, by Lord Roberts, who expressed his appreciation of their appearance and work during the past months.

On November 13th a party under Lieut. Turner blew a gap in the Armentières-Lille railway near Porte Egale Ferme; and on the 17th another party, under Lieut. Playfair, repaired the line from Armentières to Rue du Bois in order to be able to bring rations, stores, etc., up to the front line in trucks. Lieut. Turner subsequently carried out further demolitions in front of Rue du Bois.

On the 19th November the wooden wire-bound trench mortar with which experiments had been made was fired successfully—thus marking a step in the evolution of one of the nowadays numerous trench-warfare weapons. Jam-tin grenades were also made in some quantity towards the end of the month.

Mining Started.—On the 21st mining operations were started in the trenches of the Durham Light Infantry near the Rue du Bois. A trestle bridge of five spans over the River Lys was also constructed to replace the pontoons in position at Bac St. Maur.

The same work of mining, draining, construction of shelters, fascines, etc., continued during December, and as the severity of the winter increased, breastworks began to take precedence over everything else. The Company put up literally miles of breastwork revetment, and until the end of the year practically nothing occurred to vary the usual routine of trench work.

On December 26th the 1st London Field Company R.E. (T.F.) arrived as the third Field Company with the 6th Division, and were allotted to the 16th Brigade, the 12th Company taking over 17th Brigade work.

The "Truce" at Christmas.—About Christmas, and for some little time afterwards, occurred the informal "truce," during which time work was carried on in the open by day by both sides; and often at night, when an enemy searchlight was playing on our men, not a shot being fired by either side. This did not last very long, however, and the old state of things was soon reverted to.

Armentières Asylum.—On January 1st, 1915, the Company moved to the Asylum in Armentières, which, though conspicuous, proved a very comfortable billet.

On January 3rd a ruined house in "No Man's Land" was demolished successfully with explosives, and on the 23rd a barrel-pier

bridge was constructed across the moat of Porte Egale Ferme; otherwise the work continued the same as before, the daily programme being more or less as follows:—If night work had finished by 0200 hours, the first working parade was at 1030, the men having cleaned up as far as possible. If night work had lasted till after 0200, the first parade was at 1400. The men then worked till 1700 and paraded again for night work at 1900 hours, thus probably working 12 or 13 hours a day. This naturally proved too trying to last, and it was therefore decided that Sunday should be a rest day.

On February 3rd and 10th the asylum was heavily shelled, and seven men were wounded on the first and several more on the second occasion, Bugler Hayles subsequently dying of the wounds he had received. On the latter occasion great gallantry was displayed by Lance-Corporal Morgan in rescuing wounded men from a burning building which was full of poisonous fumes, for which act he subsequently received the Distinguished Conduct Medal.

Soon after this, instruction in fieldworks was given to Infantry and also to Canadian Engineers, preparatory to the latter occupying the line.

L'Epinette.—During the early days of March a considerable amount of sapping was carried out to provide "jumping-off" trenches for the attack on L'Epinette, which was shortly to take place. L.-Cpl. Driver showed great courage and resource in this work and was awarded the Distinguished Conduct Medal and Russian Order of St. George.

On March 10th the Company paraded at 2200 hours for the attack on L'Epinette, which was to be made by two Companies of the 1st Battalion North Staffordshire Regt.

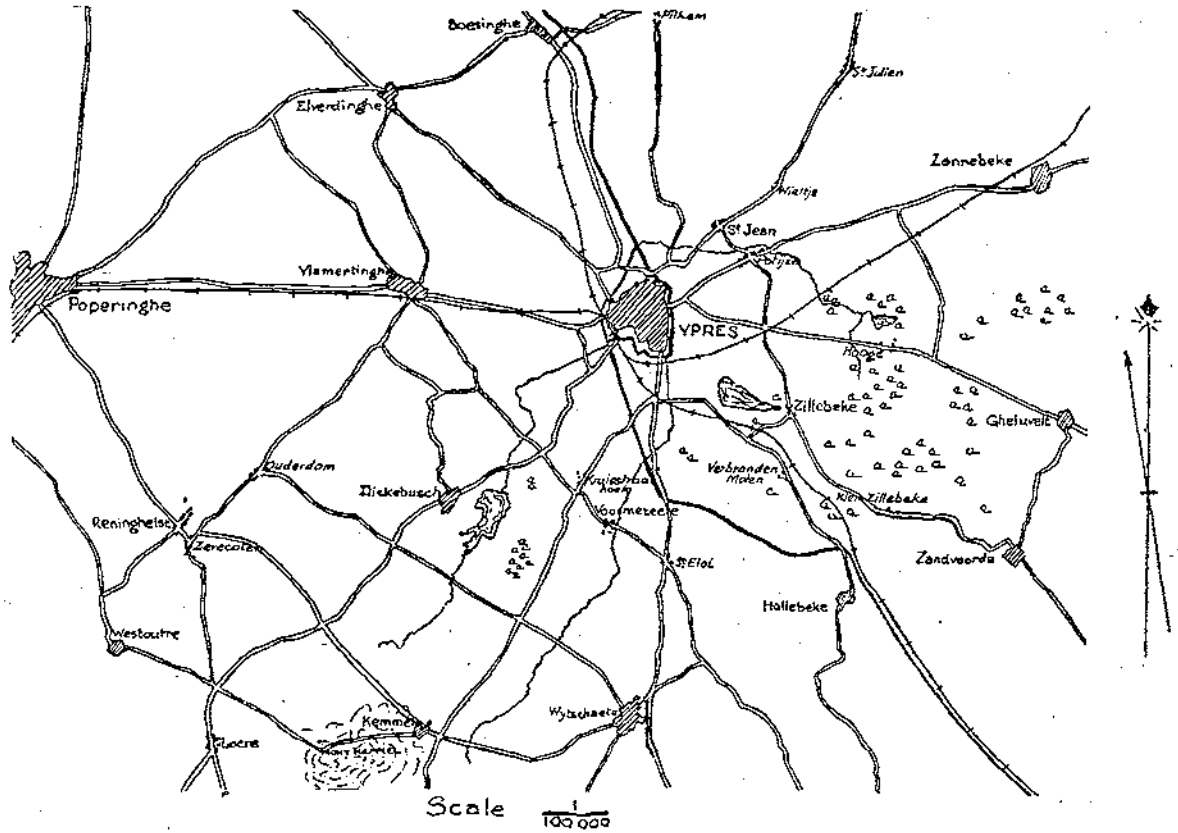
Lieut. Turner and ten men of No. 1 Section were allotted to the right, and Lieut. Jackson and ten men of No. 2 to the left, assaulting column; the remainder of Nos. 1 and 2 Sections going with the working parties of the right and left columns, while Nos. 3 and 4 Sections followed the right and left columns to help in consolidating.

The attack proved neither hazardous nor very exciting, as the enemy made practically no stand, and the village was entered very easily, the Company's casualties being only two wounded and one missing.

The work of the Company then consisted of constructing loopholes, linking up houses by means of trenches, and wiring. During the following days, however, various counter-attacks were launched by the enemy and the work of consolidation was often carried out under very heavy fire. Lieut. Turner was wounded on the 12th. On one occasion a small party of No. 2 Section under A/Serjt. Rouse were suddenly heavily attacked by a German bombing party—but after some sharp fighting they accounted successfully for all the bombers. Serjt. Rouse was awarded the D.C.M. for his conduct in this action.

YPRES.

Map IV.


Boesinghe
Elverdinghe
St Julien
Zonnebeke
Wieltje
St Jean
Vlamertinghe
Poperinghe
YPRES
Hooge
Zillebeke
Gheluvelt
Ouderdom
Dickebusch
Verbranden Molen
Klein Zillebeke
Reningelst
Zevecoten
Goemezeele
St Eloi
Zandvoorde
Hollebeke
Westoutre
Wytschaete
Kemmel
Scale 1/100 000

On the 29th, 2nd Cpl. Byrne (No. 4 Section) was in charge of the work of erecting a machine-gun emplacement in a very exposed position in the front line some 120 yards from the enemy, who were sniping and firing continuously the whole time the work was going on. In spite of the difficulties, however, it was completed satisfactorily and for this 2nd Cpl. Byrne received the Distinguished Conduct Medal.

At the beginning of April, C.S.M. J. Redmore, in company with several other R.E. Warrant Officers, was given a commission and left the Company.

The usual routine of trench work was carried out during April and most of May, and nothing unusual happened until, at the end of the month, the 6th Division moved up to the Ypres salient to relieve troops which had suffered so heavily in the recent second battle of Ypres.

Move to Ypres Salient.—On May 28th the 2nd Wessex Field Company R.E. (T.F.) arrived to take over the sector from the 12th, who marched out that day *via* Nieppe to Bailleul, subsequently moving on the 31st to Camp "A," a hutted camp near the Ypres–Vlamertinghe road. (See *Map* IV.)

The 18th Brigade, with whom the Company were now working, had moved into the line at Potijze, and for the ensuing period work was carried out on the defences of the ill-famed Potijze–St. Jean sector, consisting mainly of machine-gun emplacements, dug-outs for headquarters, revetments, wiring, the construction of duckboards, etc., at back billets, and the repair of the roads with the remains of Vlamertinghe village!

The forward sections were billeted in dug-outs in the bank of the Yser Canal, and with the help of doors, planking, etc., from Ypres, made themselves fairly comfortable.

Civilians were now again employed in the Company shops.

The billets were soon moved to a field just west of Vlamertinghe.

Attack near Railway Wood.—On June 14th and 15th preparations were made to support the 3rd Division in an attack they were going to make near Railway Wood, scaling ladders being made, assembly trenches dug, etc.

The attack was launched at 0415 hours on the 16th, No. 2 Section being with the supporting Battalion near the railway. Practically nothing happened, however, though No. 2 Section had three men wounded.

The 6th Division front was continually being altered and the Company worked on various sectors from Morteldje (opposite Pilkem) down to the Zillebeke front.

By June 26th an engine and circular saw were installed at the Company workshops.

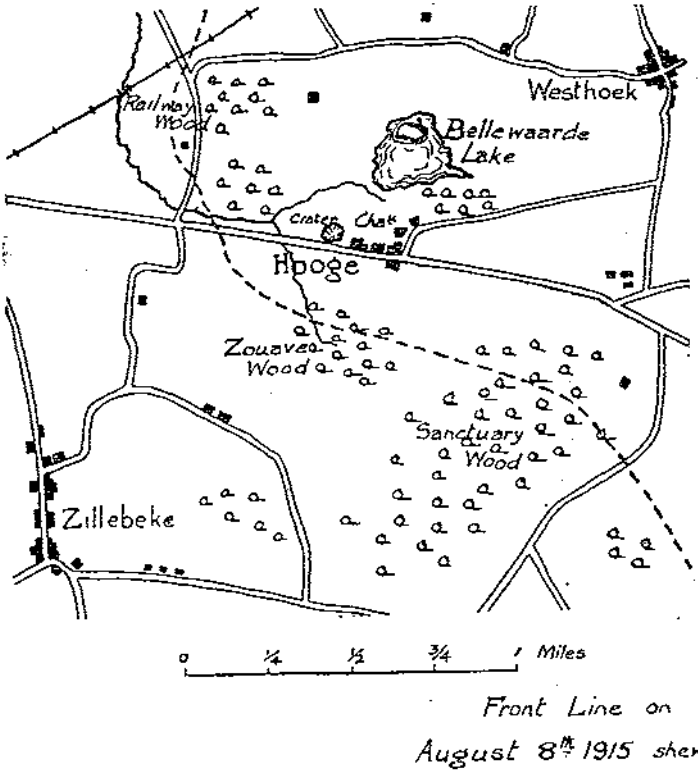
On July 12th Lieut.-Colonel Sargeaunt handed over command of the Company to Captain A. Campbell, the adjutant, and became

C.R.E. 14th Division, which appointment he was holding when he was killed on 31st August.

During July there was considerable activity in the Hooge sector, and the Company sustained several casualties, among the wounded being Lieuts. Baines and Jackson.

Hooge Crater.—On the 19th a huge crater was blown under a German redoubt at Hooge, and was captured by the 6th Division, but on the 30th, after the 6th Division had been relieved, the enemy launched a heavy counter-attack, and, with the help of their new *Flammenwerfer*, succeeded in not only recapturing the crater, but also part of our original front line. After an unsuccessful counter-attack by the troops then in the line, the 6th Division were ordered to take over their old sector and to recapture the lost ground. (See *Map* V.)

HOOGE AREA. Map. V.



Preparations were accordingly put in hand for the attack. All four sections of the Company lived in the ramparts in Ypres from the beginning of August until the attack, and worked hard on the preparations.

Attack at Hooge.—Nos. 1 and 3 Sections and 24 other N.C.O.'s and men of the 12th Company took part in the attack on the crater on

August 9th, Captain A. G. Turner being in command of the R.E., with Lieuts. Sibeth and Frecheville.

The 16th Brigade, with the 1st K.S.L.I. on the left, 2nd York and Lancs in the centre, and the D.L.I. on the right, were to advance in a north-easterly direction from Zouave Wood against the crater, which was about 500 yards distant, just north of the Menin Road.

The first line of attack consisted of bombers accompanied by four parties, each of one junior N.C.O. and three sappers, to help in blocking communication trenches. Each party carried a wooden loophole, a coil of French concertina wire and shovels, and each man had six sandbags tied to his belt.

The remainder of the 12th Company's party followed with the 2nd Battalion York and Lancaster Regt. and 1st Battalion K.S.L.I. in the second line of attack, to consolidate and erect obstacles.

The attack was launched at 0315 hours after a heavy bombardment. The casualties were heavy from the start, a large number of men being knocked out before reaching the enemy's line. The front and support lines were, however, taken, and the trench blocking parties at once got to work, blocking the communication trenches leading to the enemy's position and helping the infantry to repel constant bombing attacks.

As soon as our troops had captured all their objectives the consolidating and wiring parties started work under extremely heavy fire; carrying out wiring and digging communication trenches in the open in spite of the enormous difficulties and heavy casualties. Work was continued until nightfall, when the survivors, numbering only about 15, withdrew, and the remainder of the Company came up to continue the work of consolidation.

The losses of the 12th Company had been very heavy indeed, for out of three officers and about 60 other ranks who took part in the action, the casualties were: 1 officer (2nd Lieut. Sibeth), and 18 other ranks killed; 2 officers and 18 other ranks wounded, and 9 other ranks missing (believed killed), being 100 per cent. of officers and about 75 per cent. of other ranks.

As a result of their work the R.E. were specially mentioned for their gallantry by the G.O.C. 6th Division in his report, and the following letter was received from the G.O.C. 16th Infantry Brigade—

Commanding Royal Engineer,
6th Division.

The following is an extract from a report by Lieut.-Colonel Clemson, Commanding 2nd York and Lancaster Regt., on the action at Hooge on the 9th instant:—

"The excellent work done by the section of the 12th (Field) Co., R.E. "(under Captain Turner and Lieut. Sibeth). This section went forward "with the second line and moved through our first line under very heavy "artillery and machine-gun fire, and put up wire in front of the captured

"position. I regret their losses were very heavy—both officers were "wounded, but the remainder of the men still went on working and "when the wire was finished came back and dug communication trenches "in the open. I cannot speak too highly of their work, and this section "had the admiration of all for their bravery and coolness under the very "heavy fire."

Major Luard, Commanding 1/King's (Shropshire Light Infantry) also told me of the excellent work of the detachment 12th (Field) Co., R.E., who were with his Battalion.

I should be much obliged if you would let the 12th (Field) Company know of this, and of how much their work has always been appreciated by the 16th Infantry Brigade during the many months in which we have worked together during the war.

L. NICHOLSON, *Brig.-General*,
12/8/15. Commanding 16th Infantry Brigade.

Captain Turner was awarded the Distinguished Service Order, and L.-Cpl. Dowe and Sapper Jackson both received the D.C.M. for their gallantry during the action.

During the next fortnight the work of consolidation was carried on, nearly always under extremely heavy fire. The casualties were again very severe, 9 other ranks being killed and 3 officers and many other ranks wounded.

Inspection by General Congreve.—On August 24th the Company was at last moved out to Houtkerque for a well-earned rest. Here they remained until September 3rd, receiving reinforcements and re-organizing, during which time they were inspected by the G.O.C. 6th Division (Major-General W. N. Congreve, V.C.), who expressed his great appreciation of the work of the Royal Engineers in the recent Hooge operations.

On September 3rd the Company moved into the line once more, going up from Houtkerque by bus, two sections going into billets on the canal bank and the others into back billets south of Oosthoek.

Subsequently the headquarters and one other section moved up to the canal bank, while one section remained in back billets manufacturing material for the trench work, etc., on which the forward sections were engaged.

The Company remained thus for the rest of September, the whole of October and part of November, the work consisting, in the front line, of the usual reclamation, draining and repairing the sodden ditches which the trenches had become in the Verlorenhoek-Hooge sector, constructing shelters, machine-gun emplacements, trench tramways, etc., and, further back, on the upkeep of bridges and dug-outs on the canal, and the defences around Potijze.

On November 18th the 6th Division went out into rest, and the Company had their billets first on the Ypres-Poperinghe road and afterwards at their wagon lines on the Elverdinghe–Poperinghe road.

They remained here working on the improvement of back billets until December 15th, when they moved up once more, the forward sections taking over their old dug-outs in the canal bank.

For the next three months the Company remained here, carrying on the same work as before, and although no active operations were undertaken during this period, casualties were again heavy owing to the continual harassing fire and the very exposed nature of much of the work, 5 other ranks being killed and 3 officers (Lieuts. Playfair, Regnard and Ivory) and many other ranks wounded.

On March 15th, 1916, the Division being once more relieved, the Company marched back to Herzeele, where they rested and carried out pontooning and other training, and were inspected by the C.-in-C. on March 21st. On the 27th they moved to Calais, where they remained for four days before returning to Herzeele, where they carried out further training, in addition to giving instruction in fieldworks to the 11th Battalion Leicestershire Regt., which had joined the Division as Pioneer Battalion. This was no light task, as none of the officers or men had been on active service before and most of them had but recently been recruited. They were all very keen and eager to learn, however, and very soon an excellent liaison had sprung up between the Divisional R.E. and the Pioneers which lasted till the end of the war. An extensive reconnaissance of the Wormhout–Poperinghe area, to ascertain the extent of the water supply of the district, was also carried out in anticipation of an attack on the Pilkem Ridge later in the year.

On April 17th the Company moved up into the line again, taking over work in the 18th Infantry Brigade's sector opposite Boesinghe and adjoining the French.

The work was the same as on the previous occasions, with the addition of carrying out extensive renovations to the trench tramway system. This was interesting though difficult work, as the formation had, in many places, to be carried over swamps and marshes 50 to 60 yards in extent, and had to be capable of acting not only as a tramway formation but also as a track to and from the line. When completed this was the chief means by which rations, ammunition, stores, etc., were taken up as far as the support line.

During this time most of the working parties were subjected to heavy machine-gun fire, and the back billets were often heavily shelled, the casualties in consequence were high.

Attack near Boesinghe.—On the night of 3rd–4th June a small operation was undertaken to improve the alignment of the front on the extreme north of the sector, and to capture certain enemy posts which were enfilading the support line.

Nos. 1 and 4 Sections (Lieuts. Osmaston and Johnson) took part under the command of Captain A. Campbell. No. 1 Section was detailed to wire in the flank after the capture of the objectives,

and No. 4 were, with the help of some pioneers, to cut a communication trench through to the new position.

The attack was entirely successful, the objectives being reached at 2300 hours. No. 1 Section's work was then successfully carried out under very heavy machine-gun fire, and in spite of being wounded Lieut. Osmaston showed great courage and perseverance, remaining at the work until it was completed the next day. No. 4 Section also carried out their task satisfactorily. As a result of the gallantry they had displayed during the action Captain Campbell was awarded the D.S.O. and Lieut. Osmaston the Military Cross.

On the 16th the Company marched out to rest at Herzeele and on the 18th moved to Volkeringhove. Here, during the next ten days, an exact replica of the trenches on Pilkem Ridge was constructed, over which the Guards and 6th Divisions carried out practice assaults in anticipation of a combined attack subsequently to come off at Pilkem. Although the 6th Division did not eventually participate in the attack, this work formed the basis for the attack which was carried out by the Guards and Welsh Divisions in July, 1917.

On July 1st the Division again went into their old sector, and for the remainder of the month, with the exception of four days' rest west of Poperinghe, the Company carried out the usual work in the line and on rear defences. From the 15th to the 30th the two forward sections were billeted in cellars in Ypres. On the 31st the Company left the line and marched back to rest west of Poperinghe.

The 6th Division had now been exactly fourteen months continuously in the Ypres Salient, during which time, although there had not been many active operations by or against the enemy, the casualties had been very high and the experiences they had been through extremely trying. Nearly the whole of the salient was overlooked by the enemy's positions on the high ground in front, and a great deal was subject to enfilade fire from the flanks. The trenches in which the men had had to fight and work were mostly little more than shattered breastworks or waterlogged ditches. This meant also that the R.E. work was, with a few exceptions, of a most monotonous and trying character, having nearly all to be carried out at night, and, as all the roads and tracks in the salient were nearly always under heavy fire from both artillery and machine-guns, the working parties, on their way up to or on return from the line, went through very trying times and suffered severely.

The 6th Division Leave Ypres Salient.—It was therefore without many regrets that the Company entrained at Proven on August 3rd and said " Good-bye " to the places they had got to know only too well during their lengthy spell in the Salient.

(To be continued.)

LIEUT-GEN SIR RONALD CHARLES MAXWELL KCB KCMG
Colonal Commandant RE

MEMOIR.

LIEUT.-GENERAL SIR RONALD C. MAXWELL, K.C.B., K.C.M.G., COLONEL COMMANDANT, ROYAL ENGINEERS.

FOREWORD.

IN submitting the accompanying Memoir to his brother officers, the compiler wishes to express his thanks to those without whose aid the story could never have been told.

Firstly, to Lady Maxwell and the members of the Maxwell family, with a special word to Mrs. Hammersley, of Ridgeway, Lymington, the Henrietta of the Malta days, who, at an advanced age, retains such vivid and affectionate memories of Ronald's parents.

Secondly, to many officers outside the Corps who have helped, commencing with Field-Marshals the Earl of Ypres and Sir William Robertson, and including Colonel Evan Gibbs, R.A.S.C., and other members of Maxwell's staff who furnished the vivid accounts of his life at G.H.Q.

Finally, to the large number of brother officers who have filled in the picture as regards service in the Corps, and the terms of whose letters give such touching proofs of the affection which Ronald Maxwell inspired and which is still warm in so many hearts.

November 5th, 1924.

RONALD MAXWELL'S paternal grandfather was William Maxwell, of Carriden, near Linlithgow, an estate which his father had purchased with a fortune made in the West Indies, where he had considerable property in Antigua and Grenada. William Maxwell, who was born in 1768, and educated at Westminster School and Oxford University, entered politics at an early age as Member of Parliament for Linlithgow. He was a consistent Whig and a firm friend and supporter of Fox, Grey and Burdett. True to his principles, even when they were to his personal disadvantage, he was an ardent advocate of the abolition of slavery which ruined his estates in the West Indies and ultimately led to his selling Carriden.

As a young man, when reading with a Protestant pastor in Switzerland, he made the friendship of another boarder, Edward Bouverie, eldest son of the Hon. Edward Bouverie of Delapré Abbey, in Northamptonshire. This friendship led to Maxwell's making the acquaintance of and ultimately marrying his friend's sister, Mary Bouverie, in 1800. She died in 1816 and their eldest surviving son, born in 1806 and called Charles Francis, after his father's friends, Fox and Burdett, was the father of Ronald Maxwell.

Charles Francis Maxwell, after being educated, like his father, at Westminster School, entered the Army in 1825 as an Ensign in the 82nd Foot and became a Captain in 1832, but we first come in touch with him in 1837, when he went to Malta, as Military Secretary to his uncle, Lieut.-General Sir Henry Bouverie, G.C.M.G., K.C.B., who became Governor of the Island in that year.

Sir Henry, some years younger than his sister, Mary Maxwell, and sixteen years younger than his eldest brother Edward, had had a distinguished military career, first in the Coldstream Guards and afterwards on the Staff; at the age of nineteen he commanded a Company at the battle of Aboukir Bay, was taken prisoner in a subsequent sea-fight, was at the siege of Copenhagen in 1807, and was present at most of the principal engagements in the Peninsular War, part of the time as A.D.C. and Assistant Military Secretary to the then Sir Arthur Wellesley.

Charles Francis who, from all accounts, was a most delightful and engaging person, was an immense favourite with the veteran General, who regarded him more as a son than a nephew.

In the early days of his service at Malta he met and fell in love with Thomasine Ionia, the daughter of the Colonial Secretary, Sir Frederick Hankey, G.C.M.G., a beautiful and attractive girl, as clever as she was beautiful, and as good as she was attractive. Her mother had been a lady of Corfu, of an old Venetian Ionian family, and from her Thomasine inherited her good looks and much of her peculiar charm.

The attraction between Charles and Thomasine was mutual, they were married at home in 1839 and came out to Malta and began their happy married life in a little house in the Palace Square, adjoining the Governor's residence. Here the two eldest of their children, William and Catherine, were born, and here Mrs. Maxwell helped to mother Henry and Henrietta, the two children of Sir Henry, whose wife had died before he went to Malta. These children adored cousin Charles and his fascinating wife, and one of Henrietta's happiest recollections is of the days when the young couple used to take her, mounted on her Egyptian donkey, out riding with them.

We get a last glimpse of this pleasant party when the time came for home and they made their way there overland: the Maxwells and their children drove in one carriage, "Uncle Harry," his boy and girl with their nurse, in another. What adventures they must have had, and what sights they must have seen as they posted north through beautiful Italy and its entrancing cities; through Rome and Milan, over the Alps to the Black Forest, and so to the Channel and home.

The party broke up after reaching England, when Charles resumed regimental duty, and here we must take leave of Sir Henry, who, after refusing further employment, settled down, partly in Eaton Square and partly at Woolbeding, in Sussex, where he joined forces with his widowed sister, Mrs. Pousoutry. At both places the Maxwells and their increasing family were constant and welcome visitors until Sir Henry died suddenly in 1852, when preparing to attend the funeral of his beloved chief, the Duke of Wellington.

His only son was killed as a Captain in the Coldstream Guards at

the battle of Inkerman, but his daughter Henrietta still lives, and to her clear recollection we owe this memory of bygone days.

Charles soldiered at home for another eleven years, was Brigade-Major at Plymouth for a year in 1846–7, got his majority in 1847 and commanded his battalion on home service until he sold out in 1854.

Meantime the happy marriage was having plentiful results, and when Ronald was born at Blois, on December 26th, 1852, he was the seventh child—five more were to follow, Cedric, the next, being born in 1854, and the youngest, ten years later, in 1862.

After Colonel Maxwell left the Army the family lived for a time in Scotland, but to a larger extent abroad, partly for economy and partly to teach the children languages.

They were constant visitors, however, at Delapré, which the boys, when at school, got to look on as a second home. Uncle Edward was as kind as Uncle Harry, whilst General Everard Bouverie, who reigned at Delapré after his father's death, helped his cousin with the schooling of the increasing family and at his death left the bulk of his fortune to him he had loved so well.

Of the Maxwells' life abroad we get occasional glimpses, and of how boldly the mother used to pilot her brood all over the continent. She was an accomplished linguist herself, and used to make a practice of talking to her children, sometimes in one foreign language, sometimes in another; a friend of Ronald remembers going to see her as late as 1874, and was struck by her wonderful facility, "talking to me in English, to Ronald in French, to another son in Italian, and, indeed, I am not sure she did not speak to her daughter in yet another language, turning from one to another with perfect facility."

We hear of the family at Freiburg from one who was studying there; he tells of "the indelible impression left on the mind by a very remarkable family, which exhibited a refined type of beauty that paired with a delightful courtesy." Never did father and mother do more for their children or with better results.

The eldest son, William, died as a Vice-Admiral in 1900; whilst the third, Everard, followed him in the Navy and, when a commander full of promise, died in 1892.

Of Frederick, who was Ronald's senior by three years, and of Cedric, we shall hear again as officers of Royal Engineers.

Nigel served in the Artillery and retired as a Major in 1902, whilst Aymer retired from the Royal Munster Fusiliers, in the same year, as Captain. The remaining son, Gerald, joined the Church, and died in 1915 as Superior of the Society of the Cowley Fathers.

Of the four daughters, one died in girlhood, whilst the other three, one a widow and two unmarried, are still living.

Of the parents, Charles Francis was the first to go, and died in London in 1873, and was buried at Ham on the Thames. Thomasine outlived her husband by twenty-seven years, dying in January, 1900. She spent the latter years of her life in London, and we get a glimpse of her in those days, frail and tiny to have been the mother of twelve children, but charming, clever and very distinguished, whilst to the

end she carried traces of the beauty and attraction that won her husband's heart in those happy far-off days at Malta.

Little Ronald, already an adept in foreign languages, was sent to school at the age of twelve to the Royal Grammar School at Henley-on-Thames, where five of the brothers were educated under the Head-Mastership of Doctor Godby. He stayed at the school for six years, and a brother officer well remembers going down with Frederick to play cricket against the school and finding both Ronald and Cedric in the Eleven.

Ronald passed into Woolwich direct from school, being eleventh on the list, and he joined the Academy, then under the wise rule of Sir Lintorn Simmons, on August 6th, 1870. Besides playing cricket for the Academy, he quickly established a reputation, thanks to his up-bringing, as an excellent French and German scholar, whilst from the very first he was very smart in appearance and dress, much the best drill as well as a very good disciplinarian. As a result, and a very unusual result in those days, Ronald was selected to be Senior Under Officer in his last term over the heads of a good many more senior cadets, and in consequence he received the Sword of Honour on quitting the Academy. He also obtained the prize for German, was ninth on the list and obtained his commission in the Royal Engineers on 2nd November, 1872. A contemporary writes of Ronald in those days: "He was in the batch above me at the 'Shop,' and I carry in my memory to-day my admiration of him when he was Senior Under Officer: how handsome and débonnaire and smart he looked—an example to us cadets with his inspiring word of command on parade, so punctilious and exact in all his motions and yet with entire absence of 'side' or swagger. None more worthily gained the 'Sword of Honour' with his commission."

Ronald's commission was antedated to May 2nd, 1872, but he first joined at Chatham on January 1st, 1873, fifty-one years ago, when England, the Army and the School of Military Engineering were very different to what they are now.

Those were the days of knife-board omnibuses and hansom cabs, before lawn tennis had been invented or afternoon tea introduced; when golf was practically non-existent south of the Tweed; when all the best people in the Army, and out of it, wore side-whiskers or imperials, and when, in London, the lion on the gateway of Northumberland House still looked down upon Trafalgar Square.

In the Army, although Peninsular and Waterloo veterans were still plentiful, progress had begun, as thought had been stimulated by the Franco-German War. The great War Secretary, Mr. Cardwell, sat in Pall Mall, with the Commander-in-Chief still entrenched in his separate office at the Horse Guards, where Colonel Sir Garnet Wolseley had recently joined as an assistant Adjutant-General. Purchase had just been abolished, and the short-service system had been introduced. Autumn manœuvres had been held in 1871 and 1872, and the troops were very proud of being just armed with the then "it" of small arms, the Martini-Henry rifle. Officers' dress consisted of the tunic and the mohair-braided patrol-jacket, whilst the days of serges, and still more

of service dress, were a long way off. As a concession to Prussianism, the pantaloon and high boot had just been approved for Mounted Officers, to replace the booted overall, but the latter remained in use for many a year to come.

In the Corps itself, the Mounted portion consisted of three troops: A (Pontoon), B (Equipment), C (Telegraph); there were 27 ordinary companies and no field companies; our association with the Post Office Telegraphs had just been commenced, and two companies carried out the work. The Submarine Mining Service was still in its infancy, that service which was to prove so scientific and so effective, which for years was to attract so many of the best brains and best game players of the Corps, and which Ronald was destined to bury 32 years later.

Sir Frederick Chapman was Inspector-General of Fortifications, and Colonel Browne, Deputy Adjutant-General. The School of Military Engineering, which a few years previously had been brought up to date by Sir Lintorn Simmons, was now basking under the genial rule of Colonel Gallwey. These were the days when the Corps developed its great success at games of all kinds. The Commandant, besides being an excellent racquet player, was a deadly opponent at pool; the Brigade-Major, Major Marindin, was also Captain of the football team, the Assistant Instructor in Field Works, Capt. Merriman, was the goal-keeper, whilst the Assistant Instructor in Surveying, Capt. Fellowes, in addition to being one of the best fast bowlers in England, had been known to make 24 runs from one over by W. G. Grace.

H. W. Renny-Tailyour was at his cricket zenith and it was then that that brilliant meteor, F. W. Bennet, was flashing aross the cricket sky. The Association Football Cup was won by the Corps in 1875, and our team had made itself famous in the football world by its northern tours, when it had played and defeated the best performers in England. Colonel J. M. Grant (father of the present Commandant), as Superintendent of Military Discipline, ruled the Barrack Square, where he had, as his adjutant, Capt. Bruce Brine, with a high reputation for efficiency and smartness.

Lastly, at this time a long and lanky youth, with a parrot for his companion, was occupying in barracks a back room, which he owed to the good will of its allotted owner, Capt. R. H. Williams. This young officer's name was Kitchener; at this stage, however, indications of future greatness did not appear on the surface, and had been recognized so far by only two people: one of these was Williams and the other was the Emperor Francis Joseph. With Williams Kitchener walked, talked, went to church and fasted, commencing a life-long friendship with one whose influence over the young was as remarkable as was Ronald's to be in later years.

Ronald Maxwell's time at the S.M.E. seems to have been marked by no special incidents: he played cricket and football, but, with the galaxy of talent then available, was not in the front rank; a contemporary and intimate friend of those days speaks of Ronald's joining in everything that was going on, socially and otherwise, and tells us that the reserve that was to mark a certain period of his later career had not then developed. The same friend tells us how well he remembered,

when in camp at Wouldham in 1873, Ronald coming to tell him of his father's death; how grieved Ronald was, and how deep was the affection between father and son.

Ronald's brother Frederick, three years his senior, had left Chatham for Jamaica before Ronald joined, but Cedric came to Chatham a year before Ronald went to India and followed him there a year later.

Ronald left the S.M.E. on completing his course in November, 1874, but rejoined at Chatham in the following March for duty with the 27th Company under Capt. Peck, and stayed there until he sailed for India in the *Euphrates* on the 23rd September, 1875. He has left behind a vivid account of his experiences, of his interest and delight at a first glimpse of the East, of all the fun and characteristics of life on the old troopships. He landed at Bombay and was sent to Roorkee, where Colonel F. R. Maunsell was in command of the Sappers and Miners, with Capt. Bindon Blood as his Second-in-Command. We read in his narrative of the great review held at Delhi for the Prince of Wales (the future King Edward VII.), of the magnificence of the camps; of the native Rajahs, of the elephants with their silver howdahs and of the beautifully caparisoned horses. From Roorkee he went to Delhi with a Company of Sappers and Miners, and remained there until he joined the Public Works Department in August, 1876. At this period the officers of the Corps in India were, for the most part, so employed and had for long taken a predominating part in the great work of developing India as regards public buildings, roads, railways and irrigation. When Ronald went to India, of the 380 officer class officials in the Public Works Department, 300 were officers of Royal Engineers and but 50 R.E. officers were employed on purely military duties.

In those days the P.W.D. in India offered to the young officer the best, if not the only, chance of practice in the civil side of his profession, whilst officers so employed were always made available for military duty in case of war. It used to be alleged that officers detailed to Public Works were wont to deteriorate in military value, as well as to become slack and untidy in their personal appearance. This was doubtless true in some cases, but we can call to mind some very brilliant exceptions. Ronald was certainly one, as may be judged from the legend current in India that he used to wear starched collars in the hottest weather when others were wearing the softest they could find, and that even in the jungle, when camping alone, he made a point of always dressing for dinner.

Ronald was first of all posted to the Western Rajputana Railway at Ajmir, where he was for two years employed on construction work, after which he was sent to Calcutta as Assistant Director of State Railways, and nine months later we find him as Deputy Consulting Engineer for the Guaranteed Railways. In November, 1879, he was transferred to the Peshawar-Jalalabad Railway, and a month later his services were placed at the disposal of the Military Department for field service in the second phase of the Afghan War.

At this time Sir Frederick Roberts, after the action at Sherpur, was hardly pressed near Kabul, but his communications with Peshawar

were being kept open by and in charge of a Reserve Division. To this Division Ronald was attached as Assistant Field Engineer, but, leaving Peshawar a month later for Lundi Kotal, he was appointed Adjutant, R.E., to the Division, the C.R.E. being Major George Hills, R.E. The Division was later collected near Kabul and became the 2nd Division of the Northern Afghanistan Field Force. Meantime, Sir Donald Stewart's force (with brother Cedric in command of a Company of Sappers and Miners) had marched to relieve Kabul and defeated the Afghans at Ahmed Khel on April 19th, and the second Division was pushed out from Kabul to lend them a helping hand.

Two and a half months later, on 27th July, came the disastrous action of Maiwand, followed by the Siege of Kandahar by Ayoub Khan. This led to the famous march from Kabul to Kandahar of a specially equipped force under Roberts. Ronald was one of the few R.E. subalterns who accompanied the force, and he acted as Assistant Field Engineer under Capt. Nicholson (later known to fame as Field-Marshal Lord Nicholson), and on the staff of the second Brigade, commanded by Brig.-General T. D. Baker. The force left Kabul on the 8th of August, and fought the battle of Kandahar on the 1st of September, where Maxwell was galloper to General Baker and was the first man into Ayoub Khan's camp. A fortnight later he marched to Quetta with the second Brigade, which was then broken up, and on the 5th of October, 1880, Ronald reverted to the Public Works Department. He had not the good fortune, like Cedric, to be mentioned in dispatches, but Colonel Perkins, C.B., C.R.E. to Sir Frederick Roberts, sent in a very commendatory report on Ronald's work, and so ended satisfactorily his first essay at active service.

The next two years were spent as officiating Deputy Consulting Engineer at Lucknow, and it was while he was so employed that a brother officer ran across him at Allahabad railway station in great distress, having just returned from Secunderabad, where his brother Frederick (who had come to India in 1876 and had since been employed on railways), had been killed in an accident at polo. From Lucknow he was moved to the office of the Director-General of Railways at Calcutta, and, working between Calcutta and Simla, he stayed at this employment until January, 1885, when he accompanied Colonel Sanford, D.Q.M.G., India, on a reconnaissance up the Bori valley for a road from Dera Ghazi Khan to the Pishîn plateau above Quetta. Then came the Pendjeh scare and Maxwell found himself nominated as Adjutant, R.E., to the first Division of the Army Corps it was proposed to assemble, and in the meantime he was lent as personal assistant to the Chief Engineer of the Bolan-Hurnai railway, which was to be rapidly constructed to help the advance of the Army being collected in India. On this work Maxwell served for six months in great heat and discomfort, and through a terrible outbreak of cholera, which wrought havoc among the large collection of native workmen. For some time Maxwell had to act as doctor with the aid of a native apothecary, and as parson to bury the European subordinates who succumbed. A brother officer writes of this period: "When ordered from Quetta to Meerut, I drove down the Bolan in June, 1885, at a time when cholera was very

bad and my carriage companion was in a mortal funk. On reaching the foot of the pass at Sibi, we had to wait for the train; my companion would not quit the station, but sat with a disinfectant applied to his nose. It was very hot and a dust-storm was blowing, but I went to the R.E. tent and found Ronald and Oldfield . . . Their cook and groom had just died of cholera, but they were quite cheerful and gave me a decent dinner. It was about the most horrible place I had been in, but Ronald never groused or complained."

In due time the doctor arrived, the cholera wore itself out, and the war scare died away, and so it came about that Ronald sailed for home from Karachi on long furlough in October, 1885, just ten years after he had first arrived in India. A very complimentary report followed him home, speaking both of his capacity in office work and as to his energy and ability in construction.

It is interesting to note that for five years, from 1876 to 1881, Frederick, Ronald and Cedric were serving in India together. Cedric did all his time with the Sappers and came home in the same year as Ronald.

During his ten years of Indian service Ronald had two periods of privilege leave (three months), one of which he spent with his mother and sisters at Wiesbaden, in 1881, and the other, three years later, he devoted to a visit to Australia.

Ronald had a much-needed rest when he reached home. Some of the time was spent in travelling in France, Italy and Germany, and six months in working at Gregson's for the Staff College Examination, for which he went up in 1887. It was a difficult year for Sappers, as eight qualified for three vacancies. Captains Bethell and Sinclair were first and second on the general list and Capt. Leverson, coming tenth, got the third engineer vacancy. Ronald Maxwell and George Scott-Moncrieff were respectively thirteenth and fourteenth, and only 45 and 55 marks behind Leverson. Ronald had an attack of fever during the examination and has said that but for it he would certainly have got in. It was bad luck for him and for the Army, because the age limit prevented him from ever competing again, and in this way he lost all the advantages of the Staff College training and its attendant possibilities. On the other hand, if Ronald had succeeded he would not have been available in the next five years to do for the Corps the work we are about to describe Happily, as the list did not come out until later, his non-success cannot have spoilt Ronald's enjoyment of that wonderful summer, when, we may be sure, he saw the Jubilee and noted the brave show which the Chatham engineers made in Pall Mall. We hope, too, that Ronald and Cedric, horse-lovers both, saw Ormonde beat Minting and Bendigo on Ascot Heath in the great race of the year and of the century.

When Ronald took up home soldiering again in November, 1887, as Commander of "A" Depôt Company at Chatham, he must have become conscious of changes in his twelve years of absence. The side-whiskers, the imperials and the booted overalls had, of course, gone long ago, whilst afternoon tea and lawn-tennis had become necessaries of life; in London, Northumberland House and its Lion had made way for the Gordon Hotels.

As regards his own profession, the Home Army, or parts of it, had been almost continuously on active service in South Africa, Egypt and the Sudan.

The Duke of Cambridge, still Commander-in-Chief, had long since moved to Pall Mall, and probably had by now forgotten how much he had disliked the change, while the Inspector-General of Fortifications, Sir Lothian Nicholson, sat in the C.-in-C.'s old room at Whitehall, where for so many years the Duke of Wellington had worked.

Lord Wolseley, in full power with his brilliant following, was Adjutant-General; Sir Redvers Buller was Quartermaster-General, and Colonel Robert Grant, D.A.G.R.E. Much had been done for army efficiency and more was to follow during the coming ten years which Ronald served at home. The Corps and the organization had materially changed. Nine field companies had come into being and the old B (Equipment) Troop had disappeared, although another B (Pontoon) Troop, together with the old A Troop, composed the recently formed Bridging Battalion. C Troop had become the 1st Division of the Telegraph Battalion, and the Post Office Companies formed its second Division. The Submarine Mining Service was at its zenith and its two companies had increased to ten. Chatham he must have found very much the same, except as regards personnel. Colonel Bevan Edwards reigned instead of the genial Commandant of the old days, now a Lieut.-General and Governor of Bermuda, where he delighted his subjects by his skill and agility on the tennis court.

The Adjutant of 1873 was back again at Chatham, drilling the battalion and making it famous for its smartness and efficiency, but now *Colonel* Bruce Brine, *Assistant-Commandant.*

The young officer who in the old days kept a parrot in his room had made a name for himself in Palestine, Egypt and the Sudan, and, as Lieut.-Colonel Kitchener, C.M.G., of the Egyptian Army, was well on the road to fame, but never forgetful of the little cottage under the Sussex Downs where lived his old friend Williams.

In cricket, the ever-green Renny-Tailyour still flourished, and with him and such celebrities as Dumbleton, Friend and Hedley, the Corps had had a very successful season in 1887, losing only one match and beating the Royal Artillery twice. The glamour of the old days had gone from football, and under altered conditions we no longer competed for the Association Cup or made triumphal tours through the North.

When Ronald came to Chatham at the end of 1887, the Service and Depôt Companies still formed one battalion under the Assistant Commandant, but of such a size that it had been found expedient, in July, 1886, to appoint an Assistant Adjutant to help the regular Adjutant with the parade duties on the Square. This Assistant was Cedric Maxwell, who had been commanding a Depôt Company since January of that year. In June, 1889, however, two battalions were formed—a service battalion and a training battalion, each with its own Commander and Adjutant, and Cedric became the first Adjutant of the Training Battalion. He held this post till October, 1889, when Ronald vacated the Command of "A" Depôt Company to succeed Cedric and held the post for two years, till November, 1891, when

he vacated it on promotion to Major. Ronald then became Major of the Training Battalion for a year, after which he severed his connection with Chatham on succeeding to the command of the 17th Field Company. The "Maxwell" influence at Chatham extended over six years, during three years of which the brothers were there together: it was in this period that the brothers made their great name, and did, perhaps, their best work for the Corps. It seems necessary, at this stage, to consider them together, because they were thought of and spoken of together—those two deeply attached brothers, so like in so many respects—both enthusiastic soldiers, both high-minded, clean-living gentlemen; both good looking, smart, well-dressed and irreproachable in appearance and demeanour, with their outlook on life much the same and their ideas apparently identical. Both were wonderful drills, with resounding words of command; both were strict disciplinarians, held very much in awe by the young officers, but regarded all the same, with unbounded admiration and affection. The Sergt.-Major at Chatham of the time, a man of long experience, regarded Ronald as the greatest disciplinarian he had ever met.

They were both excellent riders and devoted to hunting, on which they usually spent their leave, and many still remember the brown mare Olga on which Ronald won the Tickham Point-to-Point Race.

As the brothers lived in the Mess, the boys saw them off as well as on parade, found them ready to talk and quick to help or give advice to any who appealed for it; many a young officer was put right in little matters of social etiquette in a way that left no feeling of soreness or wounded self-respect. In these circumstances it is no wonder that a Maxwell cult grew up at Chatham, but what does seem remarkable is that after the lapse of a generation memories are still so fresh and gratitude is still so warm—what is here written is an effort to summarize the debt which so many officers of advancing years feel they still owe to the two brothers.

Their reputation spread beyond the limits of Chatham, and when Colonel Bruce Brine, always a warm admirer of the Maxwells, came to Aldershot as C.R.E., in 1888, he used often to tell of the work they were doing, and the writer, at Aldershot at the time, recalls a certain scepticism that two such paladins could be produced who had not graduated in the School of Aldershot.

Whilst both were handsome, Cedric was the taller and perhaps better-looking. "Adonis," he was sometimes called, and more than one lady termed him the handsomest man in the Army. Cedric was almost a dandy and would wear a gayer waistcoat or a brighter tie than the more sober Ronald. Cedric was fair and had a long flowing moustache, Ronald was dark with a short moustache.

Cedric was, perhaps, the more attractive to meet, a little more approachable and with the more engaging manner, for Ronald was always a little metallic, a thin surface of hardness concealing the warm heart and kind nature beneath. Both had the appearance of the soldiers of old days. Cedric might have walked out of the pages of Dumas, whilst Ronald was reminiscent of the Knights of the Holy Sepulchre.

Ronald, as good as Cedric on parade and in the details of soldiering,

excelled him in office. Ronald had the longer head and perhaps a more tenacious and ambitious nature.

What a pity that Charles Francis was not alive to see them in those days! And how happy the reports of their successes must have made their mother in London!

The stories about the Maxwells at Chatham are endless—how Cedric warned one officer against the ignominy of a made-up tie, and another of the evils of a mourning band in plain clothes.

Two memories of one of the young officers of those times may be given. "One day on parade Ronald was riding a fidgety brown mare (probably Olga, of Point-to-Point fame) that was more at home with hounds than with troops. She was startled by the Band, swerved badly, and Ronald fell off. There was no sign of anger, he just remounted and made an apology to the officers, N.C.O.s and men for his clumsiness, although everyone who saw it knew it was not his fault."

"Another day a discussion took place in the Mess, whether an officer could kneel down in church when dressed in overalls. Ronald quietly remarked that anyone who could not kneel in church because of his overalls must have a rotten bad tailor. We all knew that he said his prayers on his knees and we also knew that he had the best-cut overalls in the station."

The following is from one who commanded a depôt company, when Ronald was Adjutant of the Training Battalion.

"He strove to abolish the idea that the command of a Company at Chatham was a sort of backwater for the inefficient, and instilled the feeling that we all had to take share and responsibility in the training of the recruits and young officers. It was in his time that improvements in the feeding and the cooking of the food for the men were pushed ahead. His guidance and assistance was appreciated by those Company Commanders who were trying to improve the amenities of the Barrack Room in the face of lack of financial help from the War Office."

"The smartness of the companies on parade was almost an innovation, and the recruit squads, when dismissed drill, would have compared favourably with a company of the Guards. To the young officer he seemed, at first, perhaps, overstrict, but they soon found sympathy under a shell of reserve due to natural shyness. But slackness he never condoned, and I remember his quiet sarcasm when an officer tried to excuse himself for being late for parade by saying that his servant had called him too late."

Colonel Champernowne, who commanded the Training Battalion during most of Ronald's time with it, wrote of him: "In this officer is combined, to an unusual degree, great strength and decision of character with tact and gentleness both towards superiors and inferiors."

It is no easy task in regard to anyone to say that here or there he did his best work, but as regards Ronald Maxwell it is difficult to exaggerate the value to the Corps and to the Army of this Chatham period of his, when his influence on those around him was so marked and made so lasting an impression on successive batches of young officers and men at the very outset of their careers.

In November, 1893, Ronald took over command of the 17th Field

Company, and held it for five years, the last three of which were spent at Aldershot, then under the command of H.R.H. the Duke of Connaught, who had the highest opinion of Maxwell's character and abilities, and who recorded his sense of the value of Maxwell's services at the New Forest manœuvres of 1895. Those who laboured in the same field will feel it is doing them no injustice to say that in Ronald Maxwell's day the 17th Field Company was second to none in efficiency. One of the subalterns of these times writes: "We had a most tremendous admiration for the Major, and were very proud of belonging to the 17th Field Company and considered our unit streets ahead of every other, owing to the Major's thoroughness in everything."

Another subaltern writes: "At that time he really seemed to have no other interest in life except his Company and hunting, and lived for and thought of nothing else. It is not, therefore, surprising that he acquired the knowledge of the men of the Corps which enabled him afterwards to do such valuable work for it."

Ronald, mounted on his black thoroughbred mare Serenade, attended the Diamond Jubilee in 1897, with a detachment of the 17th Field Company as part of the Aldershot R.E. Contingent which helped to line the route of the procession.

Serenade, however, on this occasion very nearly let her rider down. Tired and very hungry after the long wait, she stretched out as the Queen's carriage passed by and all but secured for her mid-day feed the feathers in the Royal bonnet.

Ronald Maxwell came to the top of the foreign service roster for Majors in November, 1897, and after ten years' Home service embarked once more for India. On arrival he was posted to the ordinary work of the Corps as Garrison Engineer at Mian Meer, and stayed there for five months, not finding India much changed during his twelve years' absence. In May, 1898, on the D.A.A.G. for R.E. going home on a year's leave, Maxwell, fresh from home with up-to-date knowledge, was specially put in to officiate in his place at Simla. He nearly came in for a campaign against the Mad Mullah and had been appointed C.R.E. to the Force which was to take the field when, fortunately or unfortunately, the Mullah submitted.

Whilst at Simla, Maxwell acted as Secretary to the Indian Defence Committee, and he has described in graphic terms a visit to Burmah, to be present at the rehearsal of the Rangoon Defence Scheme, and how one night, on a river steamer, a Burmese thief found his way into his cabin and carried off his dispatch-box with 500 rupees inside it.

In April, 1899, when his time as officiating D.A.A.G. was over, he was posted to Calcutta as Garrison Engineer, but four months later, on returning after a tour of inspection in Assam, he found a telegram awaiting him asking him if he would accept the command of the Training Battalion at Chatham. He hastily replied "Yes," and on the 19th August sailed for home after but a year and nine months in India. The propriety of bringing an officer home from India after so short a time was questioned in Parliament, and the reply was that a special officer was required for so important a post and that Maxwell was the most suitable.

When Maxwell took over his duties at Chatham on the 5th of September, the Boer War was within five weeks of breaking out, and the next three months after the die was cast must have been very busy ones for the Training Battalion Commander, with the call for men to fill up the new units that were being formed. Maxwell, however, was not destined for a long stay at Chatham. On the receipt of the news of the Battle of Colenso orders were issued on December 16th to mobilize the 7th Division and Maxwell was appointed its C.R.E., the Divisional General being Lieut.-General Charles Tucker. No time was lost, and on the 4th January Maxwell embarked for South Africa.

At the farewell dinner given at Chatham, the Commandant, Sir Thomas Fraser, said in his speech that, it being decided to have the very best man to command the Training Battalion, the War Office, against great opposition and contrary to all precedent, had succeeded in prevailing on the Government of India to curtail Maxwell's tour of service in that country in order that he might take up a command for which he was pre-eminently fitted.

At that time it was expected that the South African campaign would be over in six months, and so Maxwell left his quarters in Chatham all standing, with the intention of returning to complete his term of command. But this was not to be, and after a considerable time he was gazetted out of the Training Battalion and replaced.

Reaching Capetown on the 25th January, 1900, the Division was dispatched through De Aar to Orange River Station, where it formed part of the force being assembled between the Orange River and the Modder. Here during the next fortnight we find Maxwell and the Engineers of the 7th Division devising and preparing elaborate water supply arrangements for the force.

C.R.E.'s of Divisions had not a comfortable billet in South Africa: not being on the Staff they had to live with their single field company, and the result was not always happy, especially when the C.R.E. was unusually keen: fortunately in their case Maxwell and the Company Commander were old comrades and friends, not very far separated in seniority.

When the battle of Paardeburg was being fought the 7th Division was at Jacobsdal and, leaving that place at 9 p.m. on the evening of the battle (February 18th), it made a forced march and arrived on the field at 3 p.m. on the following day. On the next night (20th) the Engineers of the Division and its 14th Brigade, under Sir Herbert Chermside, moved eastward to prosecute the close attack of the Boer laager from that side on both banks of the river.

This work was executed under Maxwell's direction, and is described as follows in the Official History of the War: "Every evening before sunset Lieut.-Colonel R. C. Maxwell, C.R.E. 7th Division, and his Staff reconnoitred to the front, and were thus able to give precise orders for the capture during the night of sites which, under the protection of covering parties, were entrenched before sunrise and by the time Paardeburg fell (February 27th) Maxwell's trenches were within 250 yards of the nearest Boer trenches."

Sir Elliot Wood, who was Engineer-in-Chief of the Force, in his

interesting book, entitled *Life and Adventures in Peace and War*, is referring to this period when he says: "Above the Boer laager Chermside's Engineer Officers were daring, Colonel Maxwell reconnoitring alone down the river bank daily 200 to 300 yards in advance of the last trench and blazing trees to mark the fresh night's trench work. The enemy sniped all day from cleverly concealed trenches."

Maxwell accompanied the Division on the march to Bloemfontein, and was present at the actions of Poplar Grove, Karee Siding, Vet River and Zand River. He fell sick at Kroonstadt during the march to Pretoria, and was absent for a few weeks before he rejoined the Division at Pretoria.

When the Division was broken up and the Column fighting began, Maxwell became C.R.E. Pretoria District, January 1st, 1901, and remained at Pretoria for another year and a half, when he returned home on the conclusion of peace in June 22nd, 1902.

During his two years at Pretoria, Maxwell toiled incessantly at his job; the work to be done was unending—sanitation, hospitals, defences, not to mention a factory for the construction of the Rice pattern corrugated iron block house, which did so much to end the war.

For the great bulk of the work civil labour had to be used. Italian masons and other European artisans collected on the Rand and hundreds of native labourers; contractors had to be found and used—some good and some very bad. All this work was immensely useful and valuable, but it must have been very trying to Maxwell's ambitious spirit to see the columns coming into and going out of Pretoria commanded by officers mostly junior to himself, and not a bit more qualified, whilst he remained to make huts, latrines and defences round the town. Cedric, although desperately ill, commanded a column for the early days, and he rode and fought until he dropped—dead. We last hear of him as visiting Ronald at Pretoria, "a very nice-looking fair-haired man with a pointed golden beard, but looking so delicate."

Maxwell's assistant at this time, himself desperately anxious to fight, and tired of signing C.R.E.'s orders, which Maxwell wrote with his own pen, asked him why he never applied for a Column, and the reply was that he did not think it right to ask for things. We may regret the reply, but if he had asked, it would not have been the Maxwell we have come to know. His superiors should have pressed his claims for the fighting work for which he was so pre-eminently suited, but we presume they found him too useful and did not like to give him up. His generals all admired him and his work, and Sir Charles Tucker, in a most appreciative letter, writes of him as "a man in a thousand," whilst General Barton, for long in command of the Pretoria District, reported on him in the very highest terms. That Maxwell's services were appreciated is shown by his mention in dispatches and by the award of the C.B.

On arrival home Maxwell took over, on July 1st, 1902, the duties of A.A.G.R.E., the appointment of D.A.G.R.E., having been reduced to the lower grade when Sir William Salmond's tenure of office expired.

We now come to Ronald's romance. In 1889 he met Miss Burnaby Atkins at a Chatham ball, and ten years later, on his return from India, they met again at Rochester, and saw something of one another, until

she was summoned home and he was sent to South Africa. They had fallen in love with one another and, three years later, on his return home, they were married after a seven weeks' engagement on February 3rd, 1903. Never was there a happier marriage, not even that one at Malta sixty-four years before—one had only to meet them to know their radiant happiness, and to realize what a prize each had secured. It was good for Ronald to have someone to tell him how delightful he was; it broke through his diffidence and dissipated much of the impenetrable reserve so characteristic of his middle years.

At the War Office, Maxwell found Lord Roberts Commander-in-Chief with Sir Thomas Kelly Kenny, the Adjutant-General, as his immediate chief. Sir Richard Harrison was I.G.F., to be followed nine months later by Major-General W. T. Shone, C.B.

This state did not last long, for on February 12th, 1904, as a result of the Report of the Esher Committee, all the high officers disappeared and the War Office found itself reorganized. Maxwell now came under a new Adjutant-General, Sir Charles Douglas, whilst the work he formerly transacted with the I.G.F. he now did partly with the Director of Fortifications and Works and partly with the Inspector of Royal Engineers. In his new chief Maxwell soon found a friend and staunch supporter. The two men had many qualities in common; the same industry, the same knowledge and love of detail and to Sir Charles' appreciation Maxwell owed a great deal in the coming years.

It is hard to give any connected account of Maxwell's work as A.A.G., but, as may be expected, he put his shoulder to the wheel and worked long hours. To visitors he was always courteous, if not very expansive, and it was opposed to his view of things for officers to come and ask to be sent here or there; he would not have done it himself and did not altogether approve of other people doing it. There was immense confidence, however, in his justice, and fair play, and on occasions certainly he was out to help volunteers. One officer, now in high position, who had served under him in South Africa wrote and asked him to help him to Somaliland. Maxwell never answered the letter or referred to it afterwards, but the officer went where he wanted, and by a pure accident discovered afterwards how much trouble Maxwell had taken to bring about the result.

The D.F.W. of those days, Major-General Sir R. M. Ruck, has recorded his gratitude for the support and assistance he received from Maxwell, and how the latter backed him when, shortly after the new dispensation came into being, proposals were started to withdraw Engineer pay in order to increase the emoluments of the Cavalry. The Secretary of State supported Ruck, and as a result a committee, under Sir Evelyn Wood, was appointed to reconsider the duties of the Corps.

The report effectually safeguarded the legitimate interests of the Corps, and made a number of valuable proposals which were afterwards carried into effect, such as the provision of a Second Field Company for each Division and the organization of an R.E. Reserve of Officers, obtained with the assistance of the Institution of Civil Engineers.

At this period was sounded the death-knell of the Submarine Mining Service, involving considerable reductions in the Corps and a great deal

of reorganization in arranging for the electric lighting duties to be carried out in fortresses. All this meant work for Maxwell.

At the conclusion of his four years at the War Office and after an interval of ten days' half pay, Maxwell went to the Western Command as Brigadier-General in charge of Administration, a post he held for three years and three months, and which he vacated on promotion, three months after he became a Major-General on July 28th, 1909.

His General for the first nine months was Sir Francis Howard, and for the subsequent period Sir Charles Burnett, and both Generals found in Maxwell a tower of strength, and said so in their reports. They could go to sleep at night with the feeling that if anything went wrong in the Command it certainly would *not* be in the services which Maxwell controlled.

He was a great worker, and astonished the Administrative and Departmental Staff at Chester with the hours he kept and sometimes made them keep.

One writes: "I was very fond of Ronald Maxwell, and got on very well with him—he was a tremendous worker, with a great head for detail, and a most charming gentleman; rather too fond of doing everything himself and sitting late in the office, but notwithstanding this we all loved him, as he was straight as a die and was always very appreciative of the efforts of his subordinates."

While Maxwell was at Chester, the Territorial Scheme came into being, and, with three Divisions allotted to the Command, the task of organization was enormous and the bulk of it fell on Maxwell's shoulders.

It was at this period that he learned to speak so well in public, because his General used often to send him to represent him at functions where speech-making was required. He thus became an excellent speaker, and on the writer complimenting him about it Maxwell gave the above as an explanation.

Whilst at Chester, the Maxwells lived at Eccleston, in a little house called Riverside, on the Dee: his wife shared Maxwell's great delight in horses, and we hear of a pair of dark chestnuts at Chester that took the Maxwells on many a trip.

After leaving the Western Command, Maxwell had only 44 days' half pay before he took over the duties of Major-General in charge of Administration, Southern Command, on December 11th, 1909, where he found his former chief, Sir Charles Douglas, as G.O.C.-in-C.

The Administration of the Southern Command was in many respects a larger problem than that of the Western Command. There were many more regular troops to deal with, both on Salisbury Plain and in the two fortresses of Portsmouth and Plymouth, whilst there were unlimited camps and manœuvre arrangements in the summer. His administrative work at the manœuvres of 1910 came in for very high commendation, and marked him out as eminently fitted for such work in time of war.

If the office hours were long at Chester, they were longer still at Salisbury; he was in the office nearly twelve hours a day, and his home saw little of him during these two years. But, if Sir Charles Douglas was a task-master, he had the highest opinion of Maxwell's administrative

merits, describing him as the best administrative staff officer he had ever met, and recommending him confidently as fitted for the post of Quarter-master-General.

Whilst at Salisbury, the Maxwells lived in a charming old house, The Moat, at Britford, where by the running water of the moat the kingfishers used to build. At Longford Castle, hard by, Ronald must have been interested to see again the pictures that used to hang in the dining-room at Delapré Abbey in his schoolboy days, of his beautiful great-grandmother, painted by Reynolds, of the "Uncle Harry" of happy Malta days, and of "Cousin Everard," who had been so good a friend to two generations of Maxwells.

Maxwell remained at Salisbury for just two years, when he was transferred to the Command of the Eastern Coast Defences at Chatham on December 17th, 1911.

After the labours of Salisbury, Maxwell must have been glad to get a Command of his own, and at a place which he knew so well, and here he served for two years and eight months, until the first month of the Great War. The Chatham time was the happiest of all for the Maxwells. Ronald did not have to work so hard, and even took to playing golf in the afternoons with his A.D.C. They still had horses and spare hours in which to ride them. The nice old General's Quarters in Chatham Barracks, with its large walled garden, was ideal for entertaining; Ronald liked gathering there his soldier, sailor and civilian friends, and his wife felt that for the first time she was having a share in his work.

His most important official task at Chatham seems to have been the preparation of the Defence Scheme. In a paper which he has left behind is stated: "It took me and my Staff two years to work out all the details for the Eastern Coast Defences, to choose the positions to be held, to design the works to be executed, to make a detailed distribution of the troops placed at disposal on mobilization, and to arrange beforehand all questions of transport and supply, in addition to planning the hutting to be executed."

It is not often that such preparations are destined to be put to an early test, but in this case Maxwell and his Staff had their reward, for when mobilization came in August, 1914, and all the outside troops allotted to the defences arrived, everything was in order and the whole complicated machine worked without a hitch.

In the winter of 1911–12 the Maxwells went on leave to Freiburg, in South Germany, where at one time the Maxwell family had resided, and Ronald paid a visit to the G.O.C. of the Baden Corps. They had a long and agreeable conversation in German about the relations between England and Germany; when bidding the Baden General good-bye, Maxwell told him he was in command of the Eastern Coast Defences, and said, "If you ever come to England, I shall be the first to welcome you, whether you come in peace or war." On the German replying that he would come in war, Maxwell asked him why, and the reply was that there must be war, and that England and Germany would have to be on opposite sides, as they were the two most powerful nations, and were competitors for the trade of the world.

Sir James Grierson was Maxwell's G.O.C.-in-C. during his time at

Chatham, and highly appreciated his work at Staff rides and elsewhere, and believed in him as having all the knowledge and qualities for a Command in the Field.

In the interludes of preparing the defence scheme we may be sure that Ronald kept a watchful eye on the well-being and efficiency of his Command, and not least of his own Corps.

One who was then commanding the Training Battalion writes: "One always felt how much he appreciated our efforts to attain to those high ideals which he himself had done so much to inculcate when in the Corps."

We owe to the same source the following humorous and characteristic account of an incident which occurred at the mobilization in 1914.

"In those days the Training Battalion became an emergency battalion on mobilization for the defence of the Chattenden magazines, an emergency which actually materialized, although I do not think many of us appreciated how soon our make-believe mobilization would be practically tested. Anyway, the General was under no illusions in the matter, and one very hot summer's day I, as O.C. Emergency Battalion, was directed to report to his office; when I was ushered in, he was in his chair, beautifully turned out, cool, calm and collected, with a new row of ribbons on his chest. Although he was always particularly courteous, I was painfully aware that I had no ribbons on and that my buttons had not been properly cleaned since early morning parade. A huge map of the magazines was in front of the General, and behind him stood the Chief Engineer.

"I was requested to give my views of the defence. A discussion arose as to a particular site, and down came the Chief Engineer's finger in clammy haste over the General's shoulder on to the beautiful map. The General silently applied his forefinger and thumb to the offending finger and removed it to one side, and the Chief Engineer gave me a look.

"The discussion was resumed; after some little time we again became lost in argument, and once more the Chief Engineer's finger descended swiftly to imprint itself on the map. Exactly the same procedure was adopted, and the General courteously but firmly, with no word spoken, once more removed the finger. This time the Chief Engineer looked at me and winked, but the incident was not repeated."

At the end of August, 1914, Lord Kitchener sent for Maxwell to the War Office, where everybody was busy over the raising of the first of the New Armies. Here, with the title of Assistant to the Chief of the General Staff, Maxwell was for three weeks employed in supervising how the work of expansion was proceeding; he had to go to Lord Kitchener every morning to tell him how things were going on. Lord Kitchener wanted to know which department was getting behindhand and required driving; one day the difficulty was tents or hutments, another day big guns, another day rifles or ammunition, another day probably horses or saddlery and so on.

On September 19th, 1914, Lord Kitchener, after having received Maxwell's morning report, told him that he was going to be sent as Inspector-General of Communications to France, and that the sooner he started the better. Maxwell replied, "I will cross to-night." He had

some trouble in collecting his kit, which was half at Chatham and half in London, but he got away that evening and crossed to France by the boat from Southampton to Havre.

When Maxwell crossed to France he was within five months of being 62, and of being compulsorily retired at that age. He had been unfortunate in never getting any brevet promotion, with the result that when he became a general officer he was considerably older than most men of his rank. In August, 1914, of the 50 Generals above him on the list, only six were older than he, and of those not one served in France; throughout the war Maxwell was working alongside of men many years younger than he. When he became I.G.C. the only officer in France his senior in age, and that only by three months, was Sir John French, and when the Command changed fifteen months later, Maxwell became much the oldest senior officer in France; he had as his chief one nine years younger, whilst the Army Commanders and his colleagues at G.H.Q. averaged ten years less than he in age.

These facts are mentioned because, without them, the full merit of Maxwell's achievement is missed; they help us also to understand how young he must have been and was for his years; no one meeting him casually would have put him down at anything like his actual age.

Maxwell, with the temporary rank of Lieut.-General, took over the charge of the Communications in France at a very difficult moment. It had become necessary to transfer our bases at Calais, Boulogne and Havre to Nantes and St. Nazaire on the Loire, and in the necessarily hurried move there was inevitable confusion. This had to be put straight and hardly had that been done when early in October the former bases had to be resumed. The Indian Contingent and other Divisions were shortly due to arrive, and order had to be evolved from something not far removed from chaos.

On arrival, he made a hurried visit to G.H.Q., at Fère-en-Tardenois, to receive instructions, and then went back to the H.Q.L. of C. near Paris, where he took over the duties on September 22nd.

Maxwell tackled the job with his customary energy and self-denial. He neither spared himself nor others, and the order of the day was usually, office from 8 a.m. to midnight, and sometimes later, with the shortest of breaks for meals and 1 to 1½ hours in the afternoon invariably set aside for walking or riding exercises.

The H.Q.L. of C. were moved to Abbeville on October 15th, by which time it may be said that the L. of C. was an organized concern.

During the four months he was I.G.C., Maxwell worked in the closest touch with and the most willing subordination to the Q.M.G. in France, Sir William Robertson, who found Maxwell a great help and ready to modify the organization contemplated by the pre-war regulations to what actuality seemed to require.

Maxwell was I.G.C. sufficiently long to be able to place the organization of the L. of C. on a sound basis designed to meet the inevitable expansion of the Army from 6 to 60 Divisions. A Staff Officer writes:—

"I would assess his achievement in founding the organization of the L. of C., as he did, as almost the most successful of his efforts. The task suited him in every way. It required very thorough, painstaking, careful,

really hard work. No detail could be overlooked, for the omission of a detail might have weakened the whole fabric. General Maxwell got down to it all and plodded away at it ceaselessly; and steadily, step by step, he built it up; every piece was examined carefully, then fitted in firmly and truly in its proper place at the right time. His work was always systematic, it was not improvisation, it was always solid organization."

At the end of January, 1915, Sir William Robertson became C.G.S. to Lord French, and on his recommendation, Maxwell, who was rewarded for his work on the L. of C. by being created a K.C.B., on 18th February, 1915, became Quartermaster-General in France on January 27th, 1915. When Maxwell joined General Headquarters, they were at Saint Omer, where they remained until 31st March, 1916, when they were moved to Montreuil.

For the first eleven months of his time as Q.M.G., Lord French was Maxwell's chief, until he was succeeded by Sir Douglas Haig on 19th December, 1915.

Of Maxwell Lord Ypres writes :—" Maxwell served with me in France, first as I.G.C., and then as Q.M.G. I found him excellent in both capacities. He rendered most valuable service to the forces in the Field, and I shall always hold his memory in the deepest gratitude for the help he gave me. He is a great loss to the service."

In sending the above to the compiler of this Memoir, the Field-Marshal adds, " I write as I do from my heart, and am truly glad to have such an opportunity of testifying to the fine qualities and character of a comrade I greatly regard, and whose loss I mourn."

Officers of the Corps will value this tribute, coming from one who, to the writer's knowledge, extending over many years, has always been a warm supporter of the Corps and an appreciative admirer of its good and gallant service in the field.

Sir William Robertson, in writing of the 11 months when he was C.G.S. and Maxwell was Q.M.G., tells us that, having found Maxwell a great help as I.G.C., he now found him equally helpful as Q.M.G. to the C.G.S., and to the whole of the General Staff side of G.H.Q. At this period, although the Army at the Front was comparatively small, the Q.M.G. work was in many ways more difficult than subsequently; everything was new and different from what had been expected, and there were a thousand and one matters to be settled in conjunction with the French authorities which had never been thought of before. In those days, too, resources were deficient and, in consequence, the arrangements to be made were far more onerous and complicated than later on, when resources were plentiful. In the words of one of Maxwell's staff :—

" In his new appointment his work covered a wider field, although in its nature it was in many respects similar to what he had been doing as I.G.C. His activities were directed in the main to constructive organization, though, of course, he became more closely associated in the general administration of the Force, and in the higher direction of the operations in the Field. His experience as I.G.C. was invaluable to him, and his knowledge of the L. of C. enabled him to concentrate more time and attention on the forward services for which he was responsible." His successor as I.G.C., Sir T. F. Clayton, in a striking tribute to the high

character of Maxwell's work, and to the affection which he inspired, tells us how harmonious were their relations, and what support and ungrudging help he always received from Maxwell.

During Maxwell's service as Q.M.G. the Army in France was constantly expanding, and reached its maximum number just before he came home; and when the Armistice was signed, there had been a fall of 4212 in the total numbers in France.

The ration strength when Maxwell first landed in France was 101,486; it had risen to 332,082 when he became Q.M.G., and when his tenure of office came to an end, the number was 1,970,939, a total expansion of 1,869,453.

In other words, when Maxwell left France, the Army was 18 times greater than when he went there, whilst during his period as Q.M.G. the forces had increased considerably over fivefold in strength.

The reader will appreciate the immense expansion of administrative arrangements required to meet the increase and that this work of expansion was completed before Maxwell's hand had been removed from the plough.

As the size of the Force developed, and especially on the advent of large numbers of the New Divisions, transportation difficulties developed in the British zone.

It was necessary to expand the railway system, to make greater use of inland water transport, and to insure against undue congestion at the ports. To meet the situation, it was decided in the autumn of 1916 to reorganize the transportation services and to place the complete control of the whole in the hands of a Director-General of Transportation, with direct access to the Commander-in-Chief. This involved far-reaching administrative changes; the Q.M.G. lost his control of transportation services, whilst the office of I.G.C. came to an end, his transportation work going to the D.G.T. and his administrative services to the Q.M.G.; for the I.G.C. was substituted a G.O.C. L. of C. Area, in command of L. of C. troops, reinforcement depôts and base camps.

Maxwell was not at first in favour of the revolution effected, but, once the change was determined on, he laid himself out characteristically to do everything to make the new system work smoothly.

A large number of officers in the new organization were civilian specialists, given temporary Army rank, and necessarily without much knowledge of Army administration, and the transfer to them of the many transportation responsibilities could only be satisfactorily effected by their being given the utmost assistance by the senior officers of the B.E.F., and especially by the Q.M.G. The D.G.T., Sir Eric Geddes, appreciated this help from the beginning, and in his first progress report to 31st December, 1916, he wrote as follows: "I would like to acknowledge with gratitude the never-failing assistance and co-operation of the Q.M.G., not only in effecting the transfer, but in ensuring as far as could be the smooth working of the new organization. If, as I believe, it has been introduced without dislocation or friction, it is largely due to the Q.M.G.'s personal assistance."

These happy relations, so creditable to both, continued, and when Sir Eric Geddes left France, in May, 1917, for even more important

work at home, he wrote Maxwell a letter showing the warmest appreciation of the assistance received.

The staff of the Q.M.G. grew as the Force increased, and with the continued tendency to concentrate at G.H.Q. decisions in regard to administrative questions.

In October, 1917, Maxwell had two D.Q.M.G.'s under him, one dealing with movements and ammunition supply, and one for other questions; there were 4 A.Q.M.G.'s, 5 D.A.Q.M.G.'s, 5 Staff Captains, and an unascertained quantity of clerks and typewriters.

The above is quite apart from the various directors under the Q.M.G.; the Directors of Supply, Transport, Ordnance Services, Remounts, Army Veterinary Department, Postal Services, and Works. These all had to come to the Q.M.G. when any important decision had to be made. In addition to the Services implied in the above we have to remember requisitions, billets, claims, labour, salvage, agriculture, forestry and canteens, whilst up to December, 1916, Maxwell also had on his shoulders railway and inland water transport.

The enumeration of the preceding enables the reader to judge that Maxwell's day was a full one, especially when we remember how thorough he was and how determined to know about everything and to be certain that the best that could be done was carried out. The wonder is that he was able to stand the strain in the way he did.

He used to have a long day, breakfasting early, about 7.45, and then to the office all day and for much of the night, too.

One of his staff writes: "The forenoon was usually taken up to a considerable extent with visits to and from the C.G.S., A.G., and other Senior Staff Officers, and an occasional interview with the Commander-in-Chief. Then followed an almost continual seeing of papers with his staff, and the various Directors of the administrative Services and Departments. For a time he held an evening conference at 9.30 p.m., attended by representatives of each branch of his staff and by representatives of the larger directorates. When G.H.Q. increased in size and new services and departments were formed, the evening conferences lapsed, and though there were frequent meetings of those concerned in his office, daily conferences at a fixed hour were discontinued. Full-dress conferences were convened, when there were any very special developments. At all such meetings over which he presided Sir Ronald's intimate knowledge of the detailed work of each department was very noticeable. No matter how strenuous his day might be, immediately after dinner he walked briskly back to his office to tackle 3 or 4 hours' more work as keen as if he were beginning the day. On returning to G.H.Q. after a long day of inspection or being at a conference, it was just the same, he never showed signs of real fatigue. When men, 20 and 30 years younger than he, were beginning to flag and to display weariness, he would be full of vigour. His perseverance and determination were immense."

Space does not permit us to give at length the vivid descriptions available of how he interviewed his staff, always making them sit in front of him, and never behind or alongside; of the ordeals these visits sometimes were, but how calm, kind, and unruffled Maxwell always was.

Another writes: "To take papers to Q., to answer in person the written order 'Speak,' was, undoubtedly, not only to newcomers, something of an ordeal. With him, as in the case of Charles Lamb's *têtes-a-tête*, there could be no shuffling. The points of a case, and the previous correspondence connected with it, had to be mastered from A to Z, and if the superficial and bustling critic thought his methods were old-fashioned and that he could not see the wood for the trees, a closer acquaintance proved that here was a man whose amazing knowledge of detail had not dimmed his perception of broad issues or clouded his capacity for initiating and guiding the main lines of policy."

One of his directors writes: "My work brought me into daily association with him, and a more courteous chief and better type of English gentleman I have never met. With all his heavy responsibilities and the mass of work which fell on his shoulders, he was always accessible, and I cannot recall ever seeing him out of temper, impatient or petulant, and there were many happenings in those days with the British Army in France which were enough to upset the outward equanimity of the chief administrator of our Army."

Another director writes: "All I know about my old chief is that he was the whitest man I ever had the honour of serving under; even in the most trying times he never lost his temper, was always sympathetic with his subordinates, and would fight to the last ditch in their defence if he thought they had done their best."

The daily routine was happily varied by visits of inspection to the Front or attendance at conferences.

One we have already quoted writes: "He loved the French language, and was very proud of his proficiency in it. He was possibly seen at his very best when taking part in a conference at the French G.Q.G.; and conferences and discussions with the French undoubtedly gave him great enjoyment. Master of every detail of the subject under discussion, understanding and sympathizing with the severely accurate French staff methods, he seemed to revel in it all. At the end of possibly hours of excited and valuable discussion, when other British officers were obviously jaded and weary, Maxwell emerged from the meeting, looking as if he had had the most pleasant hour of life. His courteous old-world manner, his dignified and soldierly bearing, his smart and well-groomed appearance, and his punctilious attention to the French military etiquette, appealed immensely to the French, and their confidence in him was great."

His knowledge of German also came out, and on one occasion when inspecting German prisoners who were making charcoal in a forest near Rouen, he astonished the N.C.O. in charge by his knowledge of the technical terms of the industry in the prisoners' language.

Maxwell's usual daily recreation at G.H.Q. was a walk on the ramparts, or more frequently a ride for a couple of hours. It was on one of these rides, September 14th, 1916, that he had a serious accident; his horse bolted with him, gave him a bad fall and a broken wrist. This necessitated his being on the sick list for a short time; with this exception Maxwell never missed an hour's work on account of illness, or of being in the doctor's hands, during the whole time he was in France. This

incident is mentioned because an obituary notice in the *Times* said that it was this fall which caused Maxwell to return to England in 1917.

This statement was quite incorrect. Maxwell carried on for 15 months after the accident, and when the writer visited Montreuil in December, 1916, Maxwell was perfectly well, and the accident was so little regarded that the writer never even heard it mentioned.

In his life of hard work at G.H.Q. there was another side which Maxwell thoroughly enjoyed, keeping open house and entertaining a very large number of people, civil as well as military.

Maxwell, with some of his staff, was fortunate enough to occupy a fine old house filled with beautiful things, and possessing a large garden.

One of his staff writes: "I can hardly remember a meal except breakfast when we did not have guests. From His Majesty the King and the Prince of Wales downwards, the list included Archbishops, Ministers, Diplomats, Generals, English, French, and American, as well as endless people who came out from England on different missions and inquiries"; the writer, who falls under the latter category, gratefully remembers the genial atmosphere, and how completely Maxwell threw aside his work to make his guests feel at home. The same staff officer writes: "General Maxwell loved hospitality, but also had an end in view, which was to create a genial atmosphere, so as to overcome any difficulties that might crop up or had cropped up in the many and various departments under him or with the French." We quote once more from the same pen: "No one ever asked advice of him in vain, and the way in which it was given was always kind and friendly. It was so with me, and it generally began 'Well, if I were you, I should do so and so.' I never heard him grumble or say an unkind word of anybody; he never thought of himself; only of what was best, or thought best, for the carrying on of the War and the ultimate good of his country."

In December, 1917, Maxwell learnt that the War Office considered that the time had come to relieve him by a younger man, and in due course an official communication arrived from the Army Council to the effect that, while they were fully sensible of the excellent work performed by him during the past three years, they considered that, having regard to the requirements of the future, the time had come to replace him by a younger man. The Field-Marshal commanding was requested to convey to Maxwell the Council's thanks for his valuable services and unsparing devotion to duty, first as I.G.C. and subsequently as Q.M.G., in the very arduous conditions which obtained throughout the whole period of his service in France. In transmitting the above decision to Maxwell the C.-in-C. wrote: "I wish to express my high appreciation of the services rendered by you during the two years you have served under me as Q.M.G. The constantly increasing work and the large expansion of your department have been carried through without loss of efficiency, and the many difficulties you have had to contend with have been surmounted smoothly and without failure on any occasion. You will have the satisfaction of knowing that you are leaving your department in a most efficient state. I thank you most sincerely for the valuable assistance which you have given me at all times."

And so it came about that on the 23rd December, 1917, Maxwell's

active service ended, and he came home on half-pay at the close of 3 years and 3 months' service in France, during which he had devised and carried out great administrative developments and had earned for himself a high and enduring place among those who had a predominating share in carrying through to a successful conclusion the greatest struggle in which the Country has ever been engaged.

He was made a K.C.M.G. within a week of his return home, and in the Commander-in-Chief's dispatch of the 21st March, 1919, we read: "During 1916 and 1917 the duties of the Q.M.G.'s branch were ably directed during a period of constant expansion by Lieut.-General Sir Ronald Maxwell."

He had already been promoted to the rank of Lieut.-General on October 6th, 1916, whilst his services with France and Belgium were recognized by his appointment as Grand Officer both of the Legion of Honour and of the Order of the Crown of Belgium.

He left behind him in France a staff which regretted his departure and who have furnished the writer with the most striking tributes of their affection for the man, their confidence in his work, and their respect for and admiration of his abilities. Many of them, and others, had a natural pang of regret that Maxwell was not left to complete the work which he had commenced, but we have to remember that in December, 1917, the likelihood was that the War would last much longer than it eventually did; no man can stand a continuous and heavy strain indefinitely, and the Government doubtless felt that it was better to make the change when all was well rather than run the possibility of having to do so later when powers began to fail and when national disadvantage might be the result.

That Maxwell was able to direct with undiminished power the vast machine which he had devised up to the age of 65 seems an astounding physical, mental and moral achievement.

To his successor was left the task of controlling a system received in full working order, and it seems that the general lines which Maxwell had laid down were carried on unchanged until the conclusion of hostilities.

Shortly after the return from France, the Maxwells purchased The Old House at Singleton, below the Sussex Downs, and spent a great deal of their time laying out the garden and in improving the quaint and attractive house. Here we find Ronald running the Boy Scouts and doing what he could for the well-being of the little community, and it is from notes from lectures given at social centres that we have culled some of the incidents of his earlier days. He returned to the amateur stage as "King Valoroso" in Thackeray's "Rose and the Ring," and as the "Dream Maker" in the fantasy by Oliphant Down, called "A Maker of Dreams," whilst a photograph shows the ex-Quarter-Master-General dressed as a Sussex wagoner at the Singleton celebrations of that peace which Ronald had done so much to bring about.

At the conclusion of the War, Maxwell was made Chairman of the Committee which dealt with the R.E. War Memorial, and those associated with him in the work bear witness to the interest he exhibited, to his broadness of view and to the tact which guided the members to an agreed course of action.

Maxwell also took an active part in the work of the R.E. Old Comrades' Association: he became a Vice-President in 1920, and presided at the annual dinners in 1921, 1922, and 1923, and in the latter year was elected President, on General Sir Richard Harrison's finding it necessary to relinquish the post.

One of the last duties which Maxwell performed was to see the Secretary of the Association in regard to the Memorial Service to the late Sir George Scott-Moncrieff. Maxwell was then in a nursing home in London, and obviously very ill indeed, but the Secretary tells us how calm he was, how keen was his interest in the matter in hand, and how many were the questions he asked relating to the Corps and to those connected with it.

In the autumn of 1921, finding themselves in Sussex rather too far away from relations and friends, the Maxwells sold "The Old House," and in the following spring moved into Poplars, Burghfield Common, near Reading. Here they were within easy reach of brothers Nigel and Aymer, both living in Oxfordshire, whilst at Ewelme, not so far away, were Ronald's two unmarried sisters, who had settled there after their mother's death.

Ronald took the greatest interest in making the new house nice and in turning a paddock into a croquet lawn, where he played throughout the summer of 1923. There seemed more scope for him at his new home, where he was on the Rural District Council and the Board of Guardians, as well as a member of the Parochial Church Council and Chairman of the British Legion. Not very far from Newbury, he belonged to the Race Club there, and enjoyed the meetings in frequent company with his two brothers.

In these congenial circumstances, a number of happy years seemed in front of the Maxwells, but in the spring of this year (1924), Ronald began to fail, and, although everything possible was done, he gradually just faded out of existence.

He was characteristically brave and patient in his increasing weakness, and to within a week of the end used to insist on being carried out to the garden, where he could enjoy the roses he had pruned and the flowers which he and his wife had planted together.

He died peacefully on July 20th, after a few hours of unconsciousness, and to quote his wife's words, "on that last Sunday morning, as we were watching him, he put his arms down to his sides in the attitude of 'attention,' and I shall always believe he passed into the presence of the Greatest Commander-in-Chief and heard the word 'well done.'"

The funeral, simple and of a non-military character, took place at Ewelme on Wednesday, July 23rd, and after a service in the attractive old church, with its beautiful memorial to Cedric, the body of Ronald Maxwell was laid to rest in the sloping high ground above the church.

H.M.L.

November 5th, 1924.

SURVEY NOTES.

A COLONIAL Survey Section, Royal Engineers, under the command of Capt. S. W. Kirby, M.C., R.E., is now working in Johore. This survey is of peculiar interest, because it is in close touch with the hydrographic work now being carried out by H.M. Surveying Ship *Iroquois*, and depends to some extent upon the photography carried out by a unit of seaplanes. The employment of photography from the air along the coasts and rivers and covering the cleared areas of Johore is extremely interesting from a survey point of view, and promises to be most useful. Capt. Kirby is not the first surveyor to be carried about with his instruments from one point to another, but he is sufficiently nearly so to provide a striking illustration of the help which aircraft may render to a survey not only in photography but in transport over very difficult country. With these novel duties superimposed on the adventures of working in tropical forest, Capt. Kirby is to be congratulated on the interest of his job.

Air photographs will presently be taken of Hong Kong, and the survey of the leased territories with their aid (accompanied by contouring on the ground) is being undertaken by Lieut. H. Wace, R.E., with a small section (2nd Colonial Survey Section). Here, again, the work will prove of great interest. Existing maps of the leased territories are very poor and vary considerably in their ideas of position. The maps of the new edition are to be on a largish scale and will embody certain new ideas as to the use of air photographs.

The Corps has not confined its survey efforts, however, to warm latitudes. The Oxford Arctic expedition to Spitzbergen was accompanied this year by Lieut. J. R. T. Aldous, M.C., R.E., who was given leave by the War Office to proceed as a volunteer with a view to survey in North Eastland. His adventures will be told elsewhere, but he seems to have made gallant attempts in that inhospitable country to remove non-existent islands from, and to insert new bays and inlets upon, those most incomplete maps and charts which we now possess.

The Corps takes a certain part, too, in those international bodies which deal, under the International Council of Research, with geography and geodesy.

Colonel Sir Charles Close is the International Secretary of the Geographical Union, and the Chairman of the national and corresponding body. An international meeting at Brussels in April of this year included three of us as national delegates.

In September and October a meeting of the International Union of Geodesy and Geophysics was held in Madrid. Colonel H. G. Lyons, F.R.S., late R.E., is the International Secretary of this body. The geodesy section, with a large amount of business to transact, met earlier than the main body, and the British delegation included Colonel Sir Gerald

Lenox-Conyngham, Colonel E. M. Jack and Colonel H. St. J. L. Winterbotham. We may also claim considerable interest in the fourth delegate, Mr. A. R. Hinks, Secretary of the Royal Geographical Society, as an Honorary Member of the Institution. No pleasanter place than Madrid could have been chosen for this gathering, nor could any reception have been more charming or more hospitable. All of us who took part owe a debt of gratitude to our Spanish friends of the Instituto Geografico and other geographical bodies whose kindness we shall not readily forget.

Much of the value of these international meetings lies in the broad outlook and interest which result from a discussion of schemes for international co-operation. Many such schemes were discussed under the effective presidencey of Mr. Bowie, of the Coast and Geodetic Survey, and one can only hope that some good may eventuate. Perhaps the most interesting general resolution was that choosing the Hayford Ellipsoid of 1909 as the one to be used for geodetic discussions of international importance. The difficulty of mutual comprehension on such a gathering is, however, obvious. English and French are the languages of official business, and it is a moot question which gets the worst mishandling. It would be a great help if no Englishman were allowed to speak in French or to translate his own words into French, and no Frenchman were allowed similar liberties with English.

H.St.J.L.W.

BOOKS.

LES CHEMINS DE FER DE L'EST ET LA GUERRE DE 1914–18. By A. MARCHAND. (Berger-Levrault. Paris.) 1924. Price 40 francs.

THIS long book of 600 pages, with numerous plans, should prove of interest to all officers who are interested in what railways can do to further the work of their branch of the Service. Written by a high official of the Est Company, it gives the views of a technical railway man on mobilization schemes, plans of concentration and strategic moves, and on systems for meeting the requirements of an army in the field and for the evacuation of sick and wounded. It is far from being a mere catalogue of trains run or tonnages carried; figures are given here and there, but mostly only as illustrations and to enable a comparison to be made between the same work at different periods of the war, or the relative burden thrown on the railway by different offensive or defensive actions. It is well arranged in sections and chapters, and a reference to the detailed table of contents at the end enables a reader to pick out the subjects in which he is more particularly interested. At the end of each chapter is a summary of the conclusions to be drawn from the experiences described.

The writer starts with the express intention of telling, if not the whole truth, at any rate nothing but the truth, and the book is exceedingly frank. Many of the senior railway staff officers, with

whom the British came in contact, are mentioned by name or can readily be identified. In discussing different subjects the author does not hesitate to say in effect: In this case the system was wrong, but the staff officer in charge was a strong man and made it work; in that case the system was right, but the officer responsible for working it took a wrong view of his duties and it failed. The large part played by personality in war comes out time after time, and the author recognizes that not every senior civilian railway official possesses the strength of character and activity necessary to deal with the technical railway problems which arise suddenly during periods of intense military traffic.

The author takes various services of the French Army and shows how, by force of circumstances, their cherished regulations and meticulous accounting had to be abandoned. What, he asks, is the good of making up a supply train to the exact strength shown on an indent when it will be five days after the date of the indent when the rations reach the unit, or of what practical value in war time is a check made by passing every single wagon over a weighbridge at a regulating station as well as at the depôt at which it was loaded up? He lays down that, as a general rule, the worst enemies of systematic evacuation of wounded are the medical officers. He ascribes to the French Medical Officer two axioms: (1) ambulance trains are made for the wounded, not the wounded for ambulance trains, (2) the primary business of a medical officer is not to consider "the wounded" (in bulk), but the individual "patient." True as these axioms may be in theory, they are not practical propositions when applied to the transport of wounded by railway. It was impossible to provide enough ambulance trains to convey all the wounded immediately after a heavy engagement and even if they could have been provided no railway line could have carried that number of trains. The medical authorities must base their arrangements on the number of trains that can actually be run, not on the supposition that they can have an unlimited number whenever or wherever they like. It is impossible to provide a separate train for each patient; if transported by rail at all the wounded must be carried not as individuals, but in trainloads.

The author says little about British troops beyond that they required much more from the railway than French troops and that their railway discipline was far inferior. But from his own account elsewhere in the book of the behaviour of French troops it would appear that there can have been little to choose between the two nationalities. The author is extremely severe on the Americans, both as regards their discipline and the technical railway working of the lines and installations manned by them.

The author's considered opinion on the subject of military control, the opinion of a civilian railway expert who has seen railway working in an actual theatre of war, is very definite—far from being a hindrance to a railway, military control is its salvation; it has its disadvantages, but they arise not from the military organization but from the state of war.

The French railway with which the British came most into contact

was the Nord, and, incidentally, the author points out a few of the differences in the practice of the two companies. The variations were due partly to different views held by the French Staff Officers at the head of the two systems, and partly to the reaction of British methods of supply on the railway by which British requirements were met. On the Est, the military traffic was almost entirely French. But the author's critical examination of the ideas on troop moves, and on the best methods for the supply of an army in the field with which the French started the war and the modifications which experience and the force of circumstances compelled them to make, suggest a host of comparisons and new ideas. The book deserves close study by movement control staff officers, technical railway officers and officers of Army Services.

A.M.H.

LA DIVISION LEGERE AUTOMOBILE.

By Général BOULLAIRE. (Berger-Levrault. Paris.) 3 fr. 50c.

THIS little book is a reprint of a series of articles which appeared in the *Revue Militaire Française* in the spring of this year. It deals with the composition and the tactical handling of a light mechanicalized Division. The subject is dealt with in a really practical way, and all the machines or weapons referred to either exist at present, or require comparatively little alteration to render them suitable for the work required.

The whole question of the rapid movement of troops by mechanical transport has been receiving a certain amount of attention since the beginning of the Great War, and many practical experiments have been made, both in the theatre of operations, and under more peaceful conditions. Until quite recently these experiments have taken the form of the temporary mechanicalization and grouping of existing units. The first efforts towards the formation of a definite mechanicalized organization were made by the French in 1918, when a special Division of dismounted troops, carried in lorries, was formed for co-operation with the Cavalry Corps. It was unfortunate that shortage of effectives prevented this formation being tested out in the last phase of the Great War. An advance has been made in the permanent establishments of the French Army by the transformation of cavalry divisions into *Divisions Légères* composed of a mixture of cavalry with infantry and light artillery carried in lorries, armoured cars, etc.

The conquest of the Sahara by the Citroen Kegresse track vehicle is claimed by the author to mark a milestone in the evolution of mechanicalized warfare, and leads him on to consider the composition and action of a super-mobile force covering the movement of an army transported in motor vehicles. In recent experiments one of the chief difficulties experienced arose from the fact that the normal daily march of lorry columns exceeds the radius of action of cavalry and cyclists acting as a protective screen, even when the latter are working on such narrow frontages that no lateral movement is necessary to ensure the proper reconnaissance of the country. Under such conditions a cavalry

Division might be expected to move each day 80 to 100 kilometres on a front of 10 kilometres. The lorry columns could move, if unrestricted, 150 to 200 kilometres a day.

The advanced guard to a corps of two divisions carried in mechanical transport and moving on parallel roads, some 10 kilometres apart, would have to operate at a minimum distance of 20 or 30 kilometres in advance and on a front of 20 to 25 kilometres. It should possess greater speed than the main columns and be able to move straight ahead across country in order to search all ground. The reconnoitring detachments of ground and air forces of this advanced guard should operate 20 to 25 kilometres ahead of the advanced guard.

To carry out its duties of reconnaissance the advanced guard would have to move by day, whereas in theory it would be safer, and lend more to surprise if the main lorry columns moved by night. This would lead to a dangerous isolation of the advanced guard, say 150 kilometres in advance of the main body, in the evening. It will, therefore, normally be necessary to move the main body by day in bounds of 40 to 60 kilometres, the end of each bound being chosen to allow of a change of direction if required. As the advanced guard is moving so far ahead, it will be necessary to provide the main body with troops for close protection and these are treated separately.

For a force of two Divisions, as considered, the author suggests an advanced guard of a *Division Légère Automobile*, organized as follows: The front to be covered demands a certain amount of decentralization; this can be attained by dividing the front screen between three mixed brigades, each acting on a frontage of about 10 kilometres. These brigades must be strong enough to brush aside unorganized resistance, especially that of independent automatic fire weapons. For reconnaissance purposes it is suggested that each Brigade should have a squadron of light flexible track armoured cars of about 15 h.p., bullet-proof, and capable of moving across country at a speed of about 10 or 12 kilometres per hour, or along roads at about 40 kilometres per hour. Of these a group of five would be required per kilometre of front or a total of about 40 per brigade. These armoured cars would be supported by *groupes de combat* of 8 or 10 infantrymen, each *groupe* carried in a light track lorry (*camionette*), rendered splinter-proof if possible. Of these infantry in *camionettes* there should be two or three battalions in each brigade. They would, in turn, be supported by a mixed group of mechanicalized artillery, consisting of two batteries of 75-mm., one of 105-mm. and one of 65-mm. guns (for close support), and a section of engineers carried in *camionettes*. Each brigade must have a considerable amount of wireless to allow of control on wide frontages and the transmission of information.

Under the hand of the advanced guard commander there would have to be a reserve of power to enable him to break down, on a narrow front, resistance which might hang up his leading brigades, and to enable him to cross minor obstacles. These troops would include:—

One or 2 battalions in *camionettes*; 1 battalion of light tanks; various forms of armoured cars or mobile machine-guns; 2 groups of mechanicalized artillery (light and medium); 1 company of

engineers with M.T. park; 1 M.T. bridging train; Signals; Air Force; A.A. guns; medical, supply and transport units.

The close protective troops for the main body would be required to operate on the flanks and between the main columns. For the force under consideration the author suggests the following troops:—

One company in *camionettes*; 1 squadron of 40 cross-country armoured cars; 2 squadrons of cavalry.

He suggests that the work of the advanced guard would be of a similar nature to that now performed by the new *Divisions Légères*, that the personnel and material should be drawn from the latter, the chief alteration being the replacement of horses by armoured cars and *camionettes*.

The personnel for the close protective troops might be drawn from the existing Reconnaissance Detachments of line divisions and from the Corps Réconnaissance Groups. Till the supply of track vehicles becomes sufficient for the complete reorganization on the suggested lines, General Boullaire suggests that a start be made by converting cyclists units into infantry carried in *camionettes*, and the mechanicalization of the artillery.

He recognizes that the question of petrol supply is going to be a serious matter for France in war, unless she be allied to one of the powers who control a sufficient portion of the world's supply, but he looks hopefully into the future in this respect.

The book closes with an example of the move of such a mechanicalized force across the southern Somme area.

Whatever views may be held as to the soundness of the conclusions come to by the author, the book will give the student of the military art something very definite to think about. The distances and speeds spoken of in this study seem almost fantastic, but when one reflects that vehicles exist at the present time whose performances are quite up to the suggested standard, the vision is not so "Wellsian" as would appear at first sight.

The author insists that 50 per cent. of the mobility of a force depends on security, and on this assumption he builds up the necessity for these special protective forces. As the mobility, even of "track" vehicles, also depends on their power of crossing obstacles, the study of this type of warfare must appeal to all engineer officers, who may be called upon to demolish crossings over obstacles on a scale hitherto unthought of, and to repair those crossings at such a speed as will allow heavy vehicles to move each day the enormous distances aimed at in the war of the future.

R.P.P.-W.

LA METHODE D'INSTRUCTION DANS LE CADRE D'UN COMBAT DE BATAILLON.

By Commandant THIÉRY. (Berger-Levrault.) Price 6 francs.

OF all our peace-time military activities probably the most important, as it is certainly the most fascinating, is the training for war of our

subordinate leaders. It is a subject which calls for deep thought, based on wide experience, and one which merits unlimited discussion in which the practical commander, who has proved himself a successful trainer of troops, must always be allowed the last word.

M. le Commandant Thiéry is an infantry officer of great experience. He commanded a battalion with marked success during three years of war and was later employed with the French Mission in training the Polish army. That he was a successful trainer of troops is shown, not only by the test of battle, but by the fact that his method of training was adopted in the official Instructions issued in 1918 and that it has since been embodied in the French Infantry Training of 1920. His views therefore merit our closest attention.

But to print a method in the Regulations is one thing: to make that method part of the habitual mental equipment of the army is another. And Commandant Thiéry complains that not only has his method been misunderstood by the compilers of the Regulations, but that those paragraphs of the Regulations which embody it have escaped the attention of the army in general. He is one of those who recognize a *crise d'instruction* in the French infantry which, he tells us, is suffering from a loss of confidence in the value of purely infantry fighting in modern war and from the lack of a definite doctrine of training: as a result, he finds a tendency to minimum effort, an absence of definite teaching, monotony, routine and formalism. And it is in the hope of overcoming this crisis that he now explains in great detail the sections of the *Règlement Provisoire* which set forth his method of training.

Commandant Thiéry has found by experience that to allow section, platoon, and even company, leaders to frame their own tactical training schemes does not lead, as one might suppose, to the creation of initiative, but to a contrary result. He finds that they will, in general, take the line of least resistance and will avoid those operations of which their own knowledge is shaky. In particular, he finds that they will neglect that most important of all operations, the conduct of the actual infantry battle after the company has advanced from the starting line and has come to grips with the enemy. Moreover the independent training of small units produces a false and dangerous outlook; since the essence of success in battle is the close co-operation of all units and of all arms in fire and movement, and the junior leader has not the knowledge of the action of the larger formations required to frame an exercise which visualizes the action of other units and arms. It is on this experience that Commandant Thiéry bases his method.

To give the small unit, including the M.G. platoon, a definite aim, to supply this picture of co-operation and to force junior leaders to solve the difficult problems which it involves, all training, whether on the manœuvre ground or on the barrack square, should, he holds, be carried out in the framework of a battalion operation previously conducted (*dans le cadre d'un combat de bataillon*).

Suppose that the sections (we are using, for convenience, the nearest British equivalents to the French organization)—suppose that the sections have learnt to move, to open fire rapidly, to exploit this fire,

and to rally: the tactical instruction of sections and platoons then proceeds as follows:

i. The battalion commander conducts a battalion operation designed particularly to emphasize, for example, fire and movement. His criticisms are directed mainly to the action and shortcomings of the platoons and sections in this sense.

ii. On the following day the battalion commander stages a demonstration, for company, platoon and section leaders, of the action of some of the more interesting platoons in the above operation, explaining the points of his criticism.

iii. Company commanders then carry out, as company operations, one or more of the company manœuvres involved in the battalion attack, criticizing their platoons and sections for fire and movement.

iv. On the action of the various platoons so exemplified the whole of the section and platoon training in fire and movement is carried out, not only on the manœuvre ground, but also in close and open order battle drill on the parade ground. Every movement and episode practised is explained to the men as being a repetition or practice of some movement or action involved in the battalion approach march or battle which all can now visualize.

v. Finally the company and battalion operations are repeated as a test of the progress made.

vi. Another battalion operation is then carried out to teach some further principle or form of warfare, to train company commanders, for example, to co-operate with the battalion M.G., or with tanks.

The smaller unit, in fact, sees itself always acting in co-operation with other units and arms: on these lines the whole of the tactical training in the battalion is carried out.

But le Comdt. Thiéry proposes to carry his system further. He finds that battalion and even brigade commanders are not sufficiently *au fait* with the action of the larger formations in co-operation with other arms to be able to frame their battalion exercises on sound lines. He finds, as we, too, surely have found in the past, that the Regulations, remarkable as they are for their comprehensiveness and almost prophetic foresight, are yet more remarkable for their failure to get under the skin and into the habits of mind of those for whom they are intended. Generalizations, principles and theories, are apparently not readily digestible, even by French officers whom we generally credit with an appetite for such things greater than our own. "Demonstration," for most people, must accompany and not follow "explanation"; and it is difficult not to sympathize with Commandant Thiéry when he proposes to substitute for 80 pages of generalization on the co-operation of all arms, with which the *Règlement Provisoire* opens, two or three examples of divisional operations illustrated on the map and to deal in much greater practical detail, and with illustrations, with the various types and phases of battle with which the battalion will have to deal as part of a larger formation.

As in the battalion, divisional and brigade exercises should, he considers, be framed as a basis of brigade and battalion exercises; the operations and criticisms of one manœuvre season forming the framework of the battalion and brigade training of the following year.

Above all he insists at all times on the practice of co-operation: brigade training must invariably envisage the action of artillery: tanks and artillery should actually be present or should be represented by competent officers, and the effects of our own and of the enemy's fire must be shown by a system of coloured flags: in company training the action of the M.G. platoon must always be shown; while in platoon and section training the positions and movements of neighbouring units, based on the preliminary battalion and company exercises, must invariably be indicated by flags.

Such, as we understand it, is *la méthode d'instruction dans le cadre d'un combat de batallion* of M. le Commandant Thiéry by which he hopes to substitute real and live training for *laisser-faire* and formalism. The idea will appeal to many; and, whatever we may think of his proposals, we must remember this—that it is a method which he has himself employed with marked success. Designed to meet the needs of a short service army, the method should interest the engineer officer who is required by *Engineer Training* to give his unit a considerable "infantry" training in the minimum of time.

In addition to demonstrating his method, Commandant Thiéry's pamphlet gives us many interesting side-lights on the French doctrine of infantry fighting. It is written in a style less easy to read than is that of most French writers, while its vocabulary, being unfamiliar to your reviewer, should make it a useful study for those Staff College aspirants whose knowledge of the French language suffers from similar limitations.

L.V.B.

SIMPLIFIED ORGANIZATION AND ADMINISTRATION. (WITH DIAGRAMS).

By Captain R. H. D. Bolton, the Duke of Wellington's Regiment. (Gale & Polden.) 4s. 6d.

The preface of this book claims that it is intended to help those reading for the Staff College and Promotion Examinations, and also for Cadets at Woolwich and Sandhurst. There is a good deal in the book which is especially valuable to the latter class, and officers on first joining. It includes a great deal of elementary information which is often crowded out of more advanced manuals, such as examples of different types of correspondence, details of kit, hints on how to keep accounts, etc.

When, however, the author gets on to the more advanced organization and administration, required for the Staff College and Promotion Examinations, the information is rather sketchy and sometimes misleading. This is especially the case in many of the diagrams. In this connection may be mentioned the diagram of the 18-pounder Battery R.A., which would seem to show all the transport, including ammunition wagons, as being under battery headquarters and not in the sections;

the diagram of an infantry battalion fails to show that there is one officer responsible to the C.O. as O.C. Headquarter Wing; the organization and employment of Field ambulances is not clear; the Staff diagrams are not at all clear and seem to indicate the "G" is above "A" and "Q."

The desire to illustrate by diagrams, though laudable, seems to have been rather overdone.

The author would have been better advised to limit his readers to one class, preferably the Cadet and Junior Officer. A combination of the minor detail required by this class and the explanation of higher organization required for later examinations do not combine well in one book of reasonable dimensions.

The book is well referenced to the *Regulations*, well printed, and provided with plenty of blank pages for notes.

R.P.P.-W.

OPTICAL MEASURING INSTRUMENTS: THEIR CONSTRUCTION, THEORY AND USE.

By L. C. MARTIN. (Blackie & Son, Ltd. IX, 265. With Index. 8vo.) Price 17s. 6d.

THIS book deals with the construction and use of those many measuring instruments which depend upon microscopes or telescopes, or both, for their accuracy. Such instruments are theodolites and sextants, levels, range-finders, spectrometers, refractometers, curvature-measuring instruments, photometers, polarimeters and others. The field is a large one, and, except instrument-makers and professors at technical colleges, there cannot be many who are obliged, or inclined, to study all the instruments described. For the soldier, theodolites, levels and range-finders are the instruments with which he is chiefly concerned; and, even with these, he is not greatly exercised about the theory of their construction; though it may be admitted that, if life were long enough, he should find time to study this also, as well as their practical use. What the soldier and geographer, or both combined, do want, is a handy work of reference for use when trouble occurs with the instruments with which they may be observing. Thus it might be useful, in a military surveying party, to possess a book which would give information as to the construction of theodolite telescopes and micrometer-microscopes; and those who deal with range-finders might welcome a clear exposition of the principles on which these instruments are made, the errors involved, and the technical details of construction.

The book under review does, to a certain extent, meet the requirements indicated. But it is certainly not a book for a beginner. In the first few pages we meet with a reference to "the Petzval condition" without any explanation as to what this is; we find also in the first few pages Huygenian and Ramsden eye-pieces mentioned, which, of course, every schoolboy ought to be familiar with, but which, as a fact, most of us feel a little uncertain about unless we have looked them up in some reference book. Then we have an "ordinary flint and crown objective," "the second nodal point" of a lens, "the Gauss condition," "doublet

and triplet achromatic lenses," and many other specialist matters, all referred to casually without description or comment. The reviewer puts himself in the position of the observer, let us say, with a theodolite, untrained in optics or in the manufacture of instruments, who wants to find out how his instrument is made, what are its inherent defects, what he can expect from it, and, if things go wrong with telescope or microscope, how he can set them right. He will not easily find the answers in this book, although there is much good matter in it.

The chapters on levels and on range-finders are likely to be more intelligible to the military reader than some of the other chapters. The former has excellent investigation, by Major E. O. Henrici, of the collimation of the Zeiss level, and the latter contains some account of the stereoscopic principle, which has more and more to be reckoned with.

C.F.C.

APPLIED ELASTICITY.

By JOHN PRESCOTT, M.A., D.SC., Head of the Mathematics Department, College of Technology, Manchester. (Longmans, Green & Co.) Price 25s.

ALTHOUGH the theory of elasticity has received the attention of many eminent mathematicians, very few writers on mechanics devote more than a very little space to the subject.

The treatise by Dr. Prescott is essentially mathematical and not a manual for engineers, as its title might suggest, but the problems selected for discussion are entirely of practical interest, and this consideration has led, as explained in the Preface, to the adoption of the title "Applied" Elasticity.

The first three chapters are devoted to an analysis of stresses and strains, with a few applications.

I take here the opportunity of mentioning that in the past I have met engineers who seemed to regard "stress" and "strain" as synonymous. This is, of course, not so; stress is a force, whilst strain, though caused by stress, is essentially a geometrical magnitude; thus tension (stress) produces elongation (strain), and shearing stress produces shear (strain).

The six equations connecting the stresses (at a point) parallel to the axes of co-ordinates, and also the three shearing stresses about lines parallel to those axes, with the corresponding strains, have been known for more than 100 years, but as they are just as fundamental as the six equations of motion in dynamics or the six equations of equilibrium in statics, any treatise on elasticity must of necessity commence with establishing these equations.

Chapter IV is devoted to a discussion on the empirical basis of elasticity. With the contents of this chapter most officers are familiar more or less, as also with most of the results of Chapter V, which deals with the bending of beams under transverse forces.

Chapter VI is devoted to thin rods subjected to tension or thrust, and Chapter VII to the torsion of rods according to St. Venant's theory, which assumes that all elements of the bar which are of equal length are strained in the same way.

Chapter VIII deals with the energy of a strained body, and explains the principle of minimum energy, which can be very usefully applied to obtain sufficiently approximate buckling loads, and the periods of normal oscillations, etc.

Chapters IX and X relate to the transverse, longitudinal and torsional vibrations of rods, and Chapters XI–XVIII inclusive, to the stresses in curved beams and in the walls of spheres and cylinders, also to the stretching and bending of plates and the vibrations of rotating discs. The last Chapter, No. XIX, has for its object the investigation of the alteration in form of elastic bodies when pressed together.

There are three Appendices relating to the solution of certain differential equations.

The first seven chapters, though not exactly elementary, are not difficult reading, a moderate knowledge of the calculus, differential equations and of analytical solid geometry being all that is necessary. The remaining chapters are more difficult, and to understand them a knowledge of partial differential equations is required.

In the problems discussed it is assumed that the bodies concerned are isotropic, that is to say, that their elastic properties are the same in all directions. This, I think, will be generally approved of, as the discussion of allotropic (non-isotropic) bodies would have made the book much more difficult reading without adding to its practical value.

Within the limits that he has set for himself, Dr. Prescott is to be congratulated on having very lucidly treated a somewhat difficult subject. The treatise is an admirable one and should stimulate the study of elasticity.

As, at the present time, questions in this subject seldom or never appear in the mathematical Honours papers of the Universities, there is little incentive for its study. A possible reason for its omission is that, owing to the limited number of soluble problems, the subject does not lend itself to mathematical acrobatics. This consideration also may have induced Dr. Prescott to follow the example of Dr. Love and omit practice examples.

J. M. WADE, *Lieut.-Colonel.*, B.Sc. LOND.

THE CIVIL ENGINEERS' COST BOOK.

By Colonel T. E. COLEMAN, O.B.E. (E. & F. N. Spon. 4th Edition. 1924.) 10s. 6d.

A FOURTH Edition of this useful book, which was first reviewed in 1912 in Vol. XVI of this Journal, has been published.

There are many alterations in the general arrangement and a large number of new items and prices have been included, thus bringing the book up to date, both as to modern methods in engineering practice, as well as to current costs of work, plant and machinery.

In the original book a brief description of a large number of works, actually carried out in various parts of the world, together with the cost of them, was given, and this information was useful for purposes of approximate estimating, as well as serving as a partial check to the

various rates and prices given in the text. Only a few such items are included in the present edition and, as a considerable time must elapse before a sufficiency of similar examples of post-war works and their costs have been built up to serve as a guide to the estimator and, until the conditions of labour and cost of plant, materials, machinery and transport have become considerably more staple than is the case at present, great caution must be observed in applying the rates quoted generally to any specific scheme of any magnitude.

It is essentially a reference book for Civil, Mechanical, Municipal and Electrical Engineers in civil life and is a supplementary volume to the author's well-known general building price book, *Approximate Estimates*.

The rates and prices quoted are stated to be average current ones in England, which limits the usefulness of the book to the R.E. officer, but to those in this country, who may require to know the probable cost of plant and machinery, or, who may have to arrive at very rough estimates of cost for extensive services, it should prove very useful and, in addition, it permits of comparative costs of varying methods of construction being made.

Many of the prices for the same work vary considerably and, as no key to localities in which work may be performed at a quoted cost is given, the estimator, making use of the book, must exercise a considerable amount of his local knowledge of conditions in selecting suitable rates for application to his particular case.

The book is of a handy pocket size and contains, in addition to cost items, many general notes and useful data for all those who are engaged in the practice of engineering.

It is to be hoped that the author will include actual costs of executed works, as they become available, in future editions. S.J.T.

A RECORD OF THE BATTLES AND ENGAGEMENTS OF THE BRITISH ARMIES IN FRANCE AND FLANDERS, 1914–18.

By Captain E. A. JAMES, 48th (South Midland) Divisional Signals, T.A., with a Foreword by Lieut.-General Sir HUGH JEUDWINE, K.C.B., K.B.E. (Gale & Polden, Ltd.) Price 4s.

THIS book is a reproduction of articles which appeared in the *Journal of the Royal United Service Institution* in August and November, 1923, with certain corrections and additions and two admirable indexes, one of place names and one of formations. The author claims it to be an attempt to produce a record of Armies, Corps, Divisions and, in certain instances, of Infantry Brigades and Battalions engaged in these operations. As a book of reference it should prove of considerable value.

TALES OF TURKEY.

By Major E. W. C. SANDES, D.S.O., M.C., R.E. (John Murray, Albemarle Street, W.) Price 5s.

MAJOR SANDES has already gained golden opinions from the Press for his book entitled: *In Kut and Captivity with the Sixth Indian Division.*

In this first book of his he gave a very full account of the campaign in Mesopotamia towards the close of 1915. In the present volume he gives his experiences as a prisoner of war for two and a half years in Anatolia. The result is a book full of good stories and characteristic anecdotes, not only of Turks, Armenians and Russians, but also of British soldiers.

Public attention has lately been focussed on Anatolia in consequence of the Turco-Greek War of 1921–22, the tragedy of Smyrna, and the deportation of more than a million Greeks from their homes in Asia Minor.

Major Sandes has been well advised to publish the reminiscences of his two-and-a-half years in Anatolia; for a better general idea of the character of this little-known country can be obtained from reading his entertaining little book than could be gained from the study of many Blue Books.

His professed object in writing the book is entertainment rather than information. "It may help," he suggests, "to pass some idle moments without much brain fatigue."

The following specimen story may be given as a sample of the rest. It describes a conversation the author had with a British prisoner-of-war employed by the Turks on railway work in the Taurus Mountains.

The Germans were so eager for the completion of their railway tunnels that they induced the Turks to employ most of the British prisoners from Kut on this work. The valleys in the mountains were malarial and the work was very hard, and thus arose the terrible conditions under which our rank and file laboured and died. But the dauntless spirit of the survivors could not be quelled by hardship and suffering. They retained their pride of race, and though prisoners and seemingly helpless, they did their utmost to hinder their enemies and help their friends, even at the risk of flogging, starvation, and death. Let me recount a conversation with a soldier from one of the prisoners' camps near a railway station in the mountains.

"Well, sir," said he, "it was like this. There was a dozen of us in my squad, and we was doin' shuntin' work, and what not, in the sidin's of a large railway-station. Old Achmed, our *onbashi* (Corporal) was a sleepy old bird, so we talked it over among ourselves, and, says I, 'Look here, boys, we may be something prisoners, weary Willies, down-and-outs, etc., etc., but what I says is, we can still do our bit to spoil the arrangements of the blarsted Huns if we set down to it straight.' So then we put our minds to it, and we didn't 'alf play old Harry."

"Glad to hear it," said I. "And what did you do?"

"Well, sir, we got some of that 'ere hemery powder from an Armenian fitter bloke, and a small fret-saw. Then we waited till some more of those b—— Austrian airyplanes come into our siding before goin' on to Jerusalem. And then I strolls quiet-like to the *onbashi*, and I says, 'Ullo, *Kai-makam* (lieutenant-colonel), *choke-ayee bukshee* cigarette?' holding out a handful. So he takes a few and smokes like billy-oh behind a wagon with me in front of him doin' the perlite and passin' the time of day. Meanwhile, my mates was at it like sailors out for a 'oliday. They put a nice 'andful of hemery into every airyplane cylinder and sawed almost through every strut, but not quite. Oh no! Not quite. Lord! I would 'ave given somethin' to see those airyplanes take the air!"

And thus the survivors in the Taurus did their best for their country! I wish I could have done as much. Certain death would have been the lot of every man caught damaging the aeroplanes, and well they knew it. But the success of their work was shown later when General Allenby's armies were sweeping the enemy from Syria. A letter then fell into the hands of his troops, addressed from the Austrian

Air Force Commander on the Syrian front to his immediate superiors. In that letter he complained bitterly of the state in which his aeroplanes reached him, and he added that hardly any were fit to fly. Well done, indeed, comrades of the Taurus!

B.R.W.

HELD BY THE BOLSHEVIKS: THE DIARY OF A BRITISH OFFICER IN RUSSIA, 1919–20.

By Major L. E. VINING, R.E., I.S.R. (St. Catherine's Press.) 10s. 6d.

MAJOR VINING joined the Railway Mission which was endeavouring to organize Admiral Kolchak's transport in Siberia in 1919, and became engulfed in his retreat, which Major Vining says "puts the famous Retreat from Moscow in the shade," and was eventually captured by the Reds, with his party of 14 officers and N.C.O.s. A reviewer writes that "his literary style is atrocious; and yet this book, in all its simplicity, and with all its defects, is one of the best that has been published about the collapse of the Russian Empire," but one reader, at least, considers the style of this Diary in excellent keeping with the tale of cheery fortitude and devotion, which carried the writer and his comrades through such appalling difficulties and helped them to lighten the burdens, if only for a time, of so many of their fellow victims of Bolshevik tyranny. The kindly reference to R.S.M. Walters, R.E., by twenty years the oldest of the party, is not the least touching paragraph in the book, while the confidences of "George" and his five brother British Bolsheviks, whom the party found in one of the Moscow prisons, are delightful. "I told George . . . that if he was now such a rampant anti-Bolshevik and Communist after only two months' treatment, how much more would he be useful to be let loose in England after twelve months' sojourn in Russia."

F.E.G.S.

OUTLINE HISTORY OF THE RUSSO-JAPANESE WAR, 1904, UP TO THE BATTLE OF LIAO-YANG.

WITH QUESTIONS AND NOTES FOR ANSWERS.

By P.W. (London. Sifton Praed and Co., Ltd., The Map House, 67, St. James' Street, S.W.1. 1924.) Price 4s. 6d.

THIS book comprises 96 pages with 8 maps. (The map shown as the frontispiece in the table of contents is actually inserted at the end of the book.) The book is very clearly written, compact with useful information, and gives an easily absorbed picture of the campaign as a whole. The maps are adequate, but would be more easily followed if they all opened clear of the text, like No. 8. No doubt publishing costs prevent this ideal. There are one or two misprints, obvious and therefore of no great import; for example, at the top of page 8, "six 2-gun Horse Batteries" should read "two 6-gun Horse Batteries."

The book should prove very useful to officers studying for examinations in this campaign, especially if the problems put forward at the end of each chapter are honestly worked out and compared afterwards with the notes at the end of the book. There are 64 of these problems,

and the notes for answers comprise valuable tactical and strategical studies in outline. These notes also contain useful references to other works on the campaign which may be consulted when in search of further detail.

Apart from preparation for examination, this contribution to military history by P.W. will form a valuable addition to any military library.

P.N.

MAGAZINES.

THE JOURNAL OF THE ROYAL ARTILLERY.

With the October issue the *Journal of the Royal Artillery* has taken a new form: it has not only become a quarterly, but the shape and typography have been changed, so that, except for its grey cover, it now closely resembles the *Cavalry Journal*. Some of the best known writers of the Royal Regiment have united to mark the change and give it a good send-off by contributing articles. Sir Charles Callwell provides one, "On Writing for Publication"; Sir George MacMunn discourses on "The North-Western Frontier of India To-day"; Sir Edmund Ironside, on "Snow Campaigns," with a portrait of himself in arctic costume; Lieut.-Colonel Leslie writes, "The Services of the Royal Regiment of Artillery in the Peninsular War." There are the usual technical articles followed by two general ones on "The Subaltern in India" and "Soldiering and Sport in Nigeria." We miss the valuable reviews of foreign periodicals that have been a feature of the old monthly editions, but as regards contents, general get-up, illustrations, and legibility, the new Journal is a decided improvement on its predecessor and we wish it every success.

J.E.E.

REVUE MILITAIRE GÉNÉRALE.

(*June*, 1924.) *Les "Engins d'Accompagnement."* By Commandant Biswang.—The object of this article is to present simply and clearly a problem now exercising the best brains in the military circles of all the powers. Instructors will here find a full description of the characteristics of the French "*engins d'accompagnement*" of their organization, and of the current doctrine as to their tactical employment, while staffs will obtain enlightenment on the present state of the question both in France and abroad, what can be expected now, and what may be hoped for in the future. After a few preliminary observations in regard to the predominant part played in war by infantry, to which all the other arms are, strictly speaking, auxiliary, the writer defines the term "*engin d'accompagnement*" as an instrument capable of coming into action instantaneously against any obstacle impeding the advance of the infantry, one that is of great mobility and capable of following infantry over all sorts of country, one that belongs exclusively to the infantry, and is organized to engage objectives comparatively close but strictly limited in extent—in fact, an infantry gun, as distinct from the artillery weapons. Chapter I describes the properties, good and bad, of the

existing weapons: (*a*) the 37 mm. Q.F. gun, 1916 pattern; (*b*) the 81 mm. Stokes mortar, 1918 pattern. Chapter II collates from the various books of Regulations the present French doctrine in regard to the tactical employment of the weapons. (*To be continued.*)

The Peninsular War.—The continuation of the article by Commandant Grasset.—At the beginning of June, Marshal Bessières, from his headquarters at Burgos, issued orders for the reduction of Santander, but had to recall the columns on hearing of the outbreak at Valladolid, the capital of Old Castille. Torquemada resisted the French, and was pillaged and burnt as an example. Orders were then issued that peaceable inhabitants were to be spared, and Palencia was soon afterwards evacuated by the insurgents and occupied without pillage. The Emperor, from Bayonne, acting on out-of-date information, again attempted to intervene, but fortunately his orders were not received in time. Resistance at Cabezon was easily brushed aside, and the arrival of fugitives at Valladolid determined the departure of the insurgent elements. The city then declared for France and was occupied without further opposition. The various columns were now directed on Santander, which was occupied on 23rd after slight resistance entailing heavy losses to the Spaniards. A feature of all the operations was the ease with which, except for the state of the roads, the French columns moved about a rough and inhospitable country abounding in defiles, and with very little intercommunication. The Spaniards had yet to learn that crowds of badly armed and undisciplined levies, however patriotic, are no match for regular troops. (*To be continued.*)

Coal a Power in Peace and War.—Taking as his text certain remarks in Ludendorff's *Memories* that coal and iron are the bases of all industries, and the advantages accruing to Germany during the war owing to the possession, in addition to her own mines, of the iron mines of Longwy and Briey, and the coal mines of Belgium, Northern France and Poland, M. Pierre Bruneau dilates upon the subject in this article, more especially in regard to coal. His remarks deal with three periods, prior to 1914, during the war, and subsequent to the Treaty of Versailles—and if they are mainly truisms, they none the less present the facts clearly and concisely and furnish food for reflection.

Military Chronicle of Economic Questions. By Pierre Bruneau.—When discussing the general Army Organization Bill which was passed last March, the Chamber devoted great attention to the boundaries of the mobilization regions. These do not correspond with those of the economic regions, yet the G.O.C. has not only to supervise the administration of his troops, but becomes "the executive agent for industrial, agricultural, and economic mobilization, which entails strict and continuous supervision." It is to be hoped that the Act providing for the general mobilization of the nation for war will introduce the necessary modifications.

A short paragraph refers to the military, diplomatic and economic successes of the late General Peller.

Books. The following is among those reviewed:—

Le Rôle du Haut Commandement au Point de Vue Economique de 1914 à 1921. By Pierre Bruneau. (Berger-Levrault).—This book narrates

what was known of economic questions in the French army prior to 1914, and examines the French and German war plans from the economic standpoint. One chapter is devoted to the economic offensive of the High Command from 1914 to 1918, and constitutes the outstanding feature of the work, which ought to be adopted for the course of political economy in the military schools. At the present moment, when Parliament is about to discuss the Bill for national organization for war, this book appears very opportunely.

(*July*, 1924.)—*The Peninsular War.*—The article by Commandant Grasset is continued, and describes the operations before Saragossa. Here the French received a decided check, in spite of the fact that at first the most was not made of the city's adaptability for defence. A plan of the city is attached, scale about 4½ inches to 1 mile. Many of the defenders had already suffered defeat during the French advance, but defeat does not demoralize the Spaniard. In a short time he is recounting his exploits, encouraging himself, and raising the enthusiasm of his audience.—(*To be continued.*)

Les "Engins d'Accompagnement."—The article by Commandant Biswang is continued. Chapter II, a digest of the French regulations on the subject is concluded, and ends with a long quotation from an article by Commandant Gérin in the *Revue d'Infanterie* for June, 1923, which throws a strong light on the recent conception of the *fire base* as the foundation for a battalion attack. Chapter III deals with organization and traces its evolution from 1917 to the present year, when the regimental section of *engins d'accompagnement* comprises two groups, one of three 37-mm. guns, and one of three mortars.

Chapter IV argues that, owing to the limitation of the existing weapons, the *engin* of the future must be the immediately accompanying field artillery gun, but even this is not ideal, because it does not fulfil the required condition of being absolutely and always at the disposal of the infantry. Chapter V discusses the measures now adopted or on trial in foreign countries—A, Japan; B, England.—(*To be continued.*)

Autumn Manœuvres in the Rhône Valley. By Capt. René Andriot.—These manœuvres were of considerable interest, enhanced by the fact that two entirely new French formations were in action. On one side was a half brigade of *chasseurs mitrailleurs*, formed to hold suitable sectors of the front with machine-guns and automatic rifles, so as to economize man-power for use elsewhere. Each battalion consists of four normal machine-gun companies, and it is calculated that the four companies, deployed side by side, each in the necessary depth, could hold four kilometres of front. On the other side was a squadron of twenty caterpillar cars, of the same type as those which recently crossed the Sahara, and capable of transporting fire units across country. The country is vividly described and is illustrated by a map, scale 1/320,000. The general and special ideas are given and commented upon, and, without entering into a detailed description of the manœuvres, which were influenced by the large amount of material allotted to both sides, the lessons to be derived are ably and clearly brought out. (Should be read in the original.)

Military Chronicle of Economic Questions.—This month M. Pierre

Bruneau draws attention to the close intercourse now obtaining between Reserve Officers and their comrades on the active list, so much so that the former have representatives on a consultative committee in the War Ministry. This is the more commendable as many of them will constitute the connecting link with the civil population on national mobilization, and a "technical study group" has been formed in their "National Union" to collaborate in making preparation for the economic mobilization, in anti-gas measures for the protection of the civil population, and in other activities. This step should lead to *official* organizations being formed in each mobilization region, embracing specialists from every profession, to assist the Commandant in his general mobilization duties.

A. R. REYNOLDS.

REVUE MILITAIRE SUISSE.

(1924. *Nos. 7 to 9 inclusive.*)

M. JEAN FLEURIER'S article entitled *Une Légende. La faillite de la fortification permanente pendant la grande guerre*, is continued in Nos. 7 and 9; the position of Antwerp is discussed and a description given of its defences. It is pointed out that the history of Belgium since the date of the declaration of its independence revolves round Antwerp; it was by the capitulation of its citadel (Nov. 29, 1832), when the Dutch General Chassé surrendered to the French Army under Marshal Gérard, that the liberation of Belgium was completed. Further, the Belgian people are justly proud of the importance to which Antwerp has been raised by the perseverance of its sovereigns: Belgium, a country possessing practically no shipping of its own, has nevertheless the port second in importance in continental Europe. M. Fleurier enquires why it is that Antwerp, the commercial capital of Belgium, also became its military capital. The faith of the Belgian people can, he tells us, be summed up in the words "*Anvers réduit national, Anvers imprenable.*" For fifty years the Belgians nursed the idea that, in the event of the repudiation by the signatories of the Treaty of 1839 of their obligations thereunder, the Belgian Field Army could, as a final resort, take refuge behind the defences of Antwerp and hold out there against either France or Germany to await the "*intervention salvatrice*" of Great Britain. The military importance of Antwerp is attributable more particularly to historical, political and economic causes, and to military reasons to a far less extent. The place has, it is true, been frequently besieged, and in 1814 and 1832 held out for long periods against superior forces. Again, the saying of Napoleon I. that Antwerp was a loaded pistol aimed at the heart of England has been forgotten neither by the Belgian people nor by the British, and has tended to foster the idea that Antwerp occupied a strategic position of considerable value. The fact, however, is that at all times large quantities of goods, possessing immense value, are stored in the dock warehouses of the city, and, in these circumstances, it is but natural that those who have been responsible for the national defence should have sought to afford military protection to a centre of such vital importance to the prosperity

of the country. The stages by which the defences of Antwerp have been developed are set out in the original article. M. Fleurier points out that since Napoleon's time great changes have taken place which affect the strategic position of Antwerp; for instance, the delta of the Scheldt is to-day separated politically from Antwerp, so that, as long as Holland remains neutral, no military intervention *via* the Lower Scheldt is likely to take place for the purpose of securing the safety of the citadel. Further, history teaches that under the altered circumstances of war, owing to the progress made in the armament of armies, serious dangers exist in converting a populous city or town into a "*place de guerre*," and particularly so where no preliminary measures are adopted for ensuring an early evacuation therefrom of the civil population on the outbreak of war. Antwerp was intended to play the multiple rôle of a base and of a pivot of manœuvre; however, the intention to pivot the Belgian Army on Antwerp would only have been justified had the defensive organization of Belgium been planned to meet such a situation as arose in the autumn of 1914; as a matter of fact, the defensive organization was seriously defective. Liége and Namur were merely "*points fortifiés*" and were unable to fulfil their "*rôle maximum*," owing to the circumstance that *forts d'arrêt* had not been provided to cover all the passages across the Meuse; a "*zone fortifiée*" should really have been provided along the eastern frontier of Belgium. Again, in its isolated position Antwerp also was nothing more than a "*point fortifié*." A serious mistake was made, M. Fleurier points out, when, in 1906, it was decreed, against the advice of Leopold II., to dismantle the works of Termonde. Had the latter place been retained as a fortified centre, and provided with detached forts, on the lines suggested by General Liénard in 1905, a fortified zone could readily have been created in the western area of Belgium on the outbreak of war, the existence of which would, in all probability, have prevented the Germans pushing on to the Belgian coast during the early days of the Great War. When the decision was taken on September 9th, 1914, to provide defence works at Termonde and to create a fortified zone, it was already too late to do anything effective. M. Fleurier's view is that, whereas the defences of Liége and Namur were obsolete, those of Antwerp were incomplete.

W.A.J.O'M.

MILITÄR WOCHENBLATT.

25th December, 1923.—In this number appears a long and interesting criticism of the last book of General Buat on the *Strategy of Hindenburg and Ludendorff*, by General von Kuhl. After saying that there is nothing new in the book except its title, as the history of the operations in the West has already appeared some time since in a French military publication, in which Buat's appreciation of Hindenburg and Ludendorff was contained, the critic goes on to point out the necessity for contradicting Buat's assertions and opinions owing to the widespread influence abroad of French military literature.

The description of the operations in the East in the first years of the War is generally adequate, although it fails to give due prominence

to the great exploits of Tannenberg and the battles of the Masurian lakes. "As the boldly-planned German flank attack in North Poland in November, 1914, did not result in the rolling up of the entire Russian front, and as it was not possible to reap in the grand style the benefit of the brilliant second Masurian battle, Buat speaks in each case of a check. Before the battle of Tannenberg, so he relates, an intercepted Russian wireless message on 24th August disclosed the whole secret of the Russian movements so completely to the German Army Commander that it became a simple matter to bring off a decisive operation." Von Kuhl says, with regard to this, that they did not succeed in deciphering the Russian wireless till after November, 1914, but, as a matter of fact, on the 25th August important orders of the Russian Army of the Narew and Niemen came into the hands of the German Commander, but they had no influence on his decision and plan of battle; the merit of the bold leadership is in no way diminished! The main thing was the determined carrying through of the decision once it had been taken, in spite of the serious crises which ensued during the course of the battle. "It wanted strong nerves to remain firm when the news arrived that the First Corps was beaten, or when the airmen reported the advance of a fresh enemy Army Corps from the south on Neidenburg against the rear of the 1st Army Corps."

The German plan of operation, according to Buat, rested in August, 1914, on the belief that Russia, in consequence of her slow mobilization, would only be ready to take a hand after the decision had been won in France. This is called an error, quite simply, by von Kuhl. "The German General Staff were fully aware before the War that the Russian mobilization and the concentration had been appreciably accelerated, and that so long a period did not remain available for the operations in the West. That General v. Prittwitz after the battle of Gumbinnen would withdraw behind the Weichsel was, according to Buat, quite according to Count Schlieffen's idea, who had always recommended such a decision at his operation exercises. But the General Staff in August, 1914, disregarded Schlieffen's teaching, and could not make the decision to relinquish a whole province to the enemy." Here again, says von Kuhl, Buat is in error. Count Schlieffen was certainly of the conviction that in certain circumstances a province must be sacrificed in order to concentrate superior forces at the decisive point. But in the foregoing case for the German leader everything depended on maintaining himself as long as possible in advance of the Weichsel, so that time might be gained in the West to bring about the decision. If the Russians were at an early date to overcome the obstacle of the Weichsel and march on Berlin, then the War was in all probability lost. For that reason Count Schlieffen on the contrary always taught at Staff rides and War games that the strategic defence of East Prussia must be effected by offensive action, utilizing interior lines against the Narew and Niemen armies, which were separated by the Masurian lakes. Retreat behind the Weichsel was only considered as a last resort at the very last possible moment. "One would also thereby have left the Austrians to their fate."

After a reference to Buat's treatment of the difference of opinion

between Falkenhayn, on the one side, and Hindenburg and Ludendorff, on the other, concerning the 1915 operations, von Kuhl comes to what he calls the centre of gravity of Buat's efforts, his severe criticism of the German offensive in 1918. The first error that Buat finds lies in the application of a new strategical method. Earlier in the war Hindenburg and Ludendorff had always aimed at outflanking both wings of the enemy, and had reproached Falkenhayn for always attacking straight to the front like a battering-ram, as on the Yser and at Verdun. Since 1917 Hindenburg and Ludendorff themselves seem to have adopted this method. The offensive in Italy in October, 1917, for instance, and especially the attack at Riga, were trial runs of the 1918 strategy. To this von Kuhl replies that it is perfectly well known that the difference between Hindenburg–Ludendorff and Falkenhayn was of quite another kind. Falkenhayn was in no way a professor of the massed attack as distinct from the outflanking movement. "The attack at Ypres was meant precisely to effect the outflanking of the enemy's north wing, and the place chosen for the break-through at Gorlice exactly conformed to the whole situation. The difference lay far more in the fact that Falkenhayn did not consider that a final decision could be gained with the forces available, and therefore went in for a careful husbanding of those forces, whereas Ludendorff strove for a decisive victory. How it was to be obtained, depended on the situation." In the spring of 1918, opposite an enemy front stretching from the sea to Switzerland, there was no room for a "Cannæ" as at Tannenberg, and so there was no alternative but the break-through.

Buat, too, has no other solution, but is of a different opinion as to the way in which this attack should have been carried out. Two methods were open to Ludendorff: either he must use up all the enemy's reserves by a succession of partial attacks rapidly following each other, in order then to break through the enemy position by a powerful attack and so bring about the complete collapse of the opponent; or he must concentrate everything on a single blow which would have so rapid a success that the enemy's reserves could not be brought up in time. The German leaders decided on the latter solution; this was their first mistake. A string of instances is then given to show that in every case the enemy reserves arrived in time to bar the way to the exhausted attackers. "The strength of a front consists not in the fortification of the position and on its garrison, but on the number and the value of the available reserves and on the possibility of getting them quickly into position." This possibility was greater in France than in Russia on account of the extensive railway communications and the vast transport material in the former.

That Germany was not in a position to exhaust the enemy's reserves by a succession of local attacks, however desirable that might be, is overlooked by General Buat. "Also he does not relate that our March offensive, according to French and English authoritative opinions, would have led to a complete break-through on the existing gap of a width of 15 km., in which there was not a single soldier, if only some German cavalry divisions had been at hand."

Consequently in the given circumstances German G.H.Q. was

thoroughly justified in resolving on a decisive attack on 21st March, 1918. Buat disagrees with the choice of the point attacked, as the offensive led them on into the devastated area of the "Siegfried" position and of the battle of the Somme. The line of attack Arras–Abbeville suggested by Buat instead of that actually followed "was seriously considered by our headquarters, but rejected, because the attack on both sides of Arras was found to be tactically too difficult. For the limitation of the front of attack it was necessary to find a natural support for one flank. Such a support could be formed by the Somme for the offensive as actually carried out, whereas in an operation directed on Arras–Abbeville there was no possibility of this."

Von Kuhl admits that the German attack in May between Soissons and Rheims, the objective of which was originally only up to the Aisne and Vesle, by its astonishing success led right beyond these and up to the Marne, and that thereby the 7th Army found itself in an untenable position at the end of the battle. But he disagrees with Buat's assertion that German G.H.Q. had striven for a break-through on the Aisne. "The attack aimed only at a diversion. Before the decisive offensive in Flanders could be begun, the strong reserves up there must be drawn off in another direction." But the attack on the Aisne produced a brilliant victory over an enemy completely taken by surprise, so the advantage of the situation was utilized to the full to get the most possible from this success. The effort to widen the gap to right and left did not succeed, and the situation resulted in a salient up to the Marne, dangerously exposed on both flanks. To free themselves from this situation, the German G.H.Q. began, as Buat says, a fresh blunder, the attack on 15th July. The July attack on both sides of Rheims arose actually from the above forced situation. "Before the position of the 7th Army was improved, they dared not launch the attack planned against the English in Flanders."

The attack on the 15th July had a definite limited objective. Rheims was to be outflanked on both sides, and "pinched out." Von Kuhl says that Buat errs when he asserts that a decisive break-through was intended, and paints a completely imaginary picture of the German intentions.

After the failure of the July offensive and the success of the French counter-attack of the 18th July, there was a complete change in the military situation. "Buat now tries to prove that, in contradistinction to the faulty methods of attack of Hindenburg and Ludendorff, the Allies now applied a quite different and far more effective strategical method." A succession of attacks with limited objectives, following quickly one after the other, was to tire out the enemy till he had used up all his reserves. Then the day was to come when by one final great attack a decision would be won. The masses of heavy artillery and the thousands of tanks necessary for such a strategy were already on order since the beginning of 1917, and should be ready in the spring of 1918, at a time, moreover, when the intervention of the Americans was to be expected.

According to this principle they acted in the summer and autumn of 1918. "When, at the beginning of November, the Germans had only

17 divisions left in reserve, while the Allies had 103, the moment had arrived for the great blow in Lorraine, which was planned for the 14th November." Marshal Foch's skill—this is what piques von Kuhl—had proved victorious over the German leadership. "Buat forgets that the German strength after four years of war was already exhausted in the summer of 1918. After the failure of the great offensive, on which all available forces and material were concentrated, the war was lost. The German reserves no longer needed to be used up, they were that already at the end of July." Von Kuhl then goes on to show, as he thinks, that the German commanders can well bear comparison with Foch, and finishes as follows: "The German offensive in 1918 was meant to bring about a decision, just because our resources would only suffice for a limited time, because the power of resistance of the central powers was coming to an end, and because the superiority of the enemy must go on increasing as time passed. That finally our forces did not suffice to bring about a decisive victory does not prove that the decision to assume the offensive was wrong."

E.G.W.

HEERESTECHNIK.

(*August and September*, 1924, *Numbers.*)

IN the August and September numbers Major A. D. Jacobsen describes post-war activity in improving military gas methods. French, Polish and Checko-Slovakian units, schools, manufactories, etc., are described. An amusing paragraph describes Bolshevik methods of practising not only on animals, but on those condemned to death. A considerable number of casualties in the ranks and among airmen would seem to have partially avenged these victims. But such regrettable incidents are held to be compensated by the knowledge gained. Scandinavian, Belgian, Swiss and Italian measures are briefly alluded to. Our own field service regulations are quoted to show the measures we might take if gas warfare was forced upon us. Spain is described as starting experiments.

The Japanese gas bomb has a working area of two miles, and the gas hangs low on the ground. It is the American model which influences and shapes the policy of others in this matter, and American authors are quoted on their "super-gas" and on the value it is hoped to find in meeting oversea attack with gas bombs, etc. Germany's neighbours may be confidently expected to make extensive use of such methods. They will react on German tactics by:

(*a*) Causing casualties,
(*b*) Hindering movement and personal efficiency,
(*c*) Necessitating further stores and equipment.

As regards (*a*) the German mask is still efficient; regarding (*b*) several examples are quoted of the effect of gas masks on the speed of movement and on the efficiency of troops, and as regards (*c*) it is stated that a mass of additional gear had to be brought up in the Soissons-Château Thierry-Dormans area in consequence of new French gas methods. Finally

the League of Nations is alluded to as being much perplexed in the matter, and the French are given the onus of having begun gas attacks, "Codlin's the friend—not Short."

A summary of the history of the fortified bridgeheads on the Rhine is given by Dr. Speich in a short article on the dismantling of German fortresses.

In writing of forecasting long spells of weather Dr. Kölser quotes Franz Bauer, who believes that by following Schuster he has made real progress. Dr. Kölser thinks that the methods of Vercelli are of more value, but he considers that it is still impossible to forecast the main features of the weather over long periods with any approach to scientific accuracy.

Buhle writes on the draft horse. The official regulations say little as to output of energy of a draft horse nor of the factors which determine it. Further numbers on this question follow.

Poland has been busy planning and organizing her girdle of fortresses and in constructing them under French advice. The various fortified lines and the individual fortresses and bridgeheads on them are described briefly in the August number.

Major Klingbeil is of the opinion that in modern war no Division will move in one column either by night or day. The following factors are against it:

1. The development of the air arm,
2. Long-range modern artillery, using survey methods,
3. The replacement of the horse by the motor,
4. Tanks,
5. The depth necessary to allow of the reinforcement or replacement of troops as quickly used up as they were in the war.

He argues, therefore, that marches will be organized in deployed and mixed detachments, using every road, however bad, and often directed across country. The duties of the pioneer are discussed as regards bridging, road repair, reconnaissance, etc., and he advocates an organization to allow of splitting up into as many small bodies as there may be detachments.

An interesting article on "the explosive air method" begins with explaining how the call on ordinary explosives during the War compelled industry to find some substitute. This substitute was liquid oxygen in conjunction with carbon—$C + O_2$ becoming CO_2 with such explosive force as to outdo all other explosives. Air is liquified and the oxygen, cleansed from all impurities, cased up in bottles on the thermostat model. This liquid oxygen is used to saturate carbon cartridges in which the hole for the fuze or detonator is previously made. (The cartridge is frozen hard, of course, so that no hole could then be bored in it.)

The cartridge is now ready, and remains explosive for some $\frac{1}{4}$ to $\frac{1}{2}$ hour. At the end of that period the oxygen has evaporated out and the cartridge is safe again. There are certain defects. No bottle can be designed to keep the oxygen from leaking out—and the leaking is worse, naturally, in transit. In fact, 25 kilometres appears to be the range to which the oxygen can be carried.

On the other hand, the comparative ease of manufacture, safety in handling, and explosive energy, are, it is claimed, sufficiently great advantages to make it the explosive of industry of the future.

The 10th volume of *The Great War*, 1914–18, by M. Schwarte, *Organizations dealing with the moral life of the Army*, has now appeared. Included are chapters on the German military government in Belgium, Military Law, arrangements for German prisoners of war, religious work in the field, care of the injured, graves, morale, care of objects of art, and the High Command. The reason for the inclusion of all these apparently heterogeneous items is given, and the book warmly reviewed.

H.St.J.L.W.

VOINA I MIR.

No. 12.—The article on "Landing Operations and Coast Defence," by E. Dostovalov, which was begun in the tenth number, is continued. The author gives a brief description of the British landing operations in Gallipoli. He discusses the principles on which success in such operations must depend under the following heads: secrecy in preparation, unchallenged command of the sea and air, material resources, proximity of bases to the scene of operations, choice of landing places, time of landing, training and moral qualities of the troops and leaders, degree of previous technical preparation.

He thinks that in future landing operations special armoured motor-boats and amphibious tanks may be used, but that the air fleet will have a powerful influence on the success of the operations. The tasks of the Air Force of the attack will be:—

(1) Reconnaissance of the coast line; (2) active assistance during the landing by bombing and fire; (3) maintenance of aerial supremacy; (4) correction of artillery fire.

Owing to the difficulties of establishing aerial bases and the demand on air-craft for escorting transports, the advantages in aerial operations will naturally rest with the defence. He considers that amphibious tanks would be most useful in the initial stages of a landing for assisting the advanced guard to seize quickly important points. They would have to be towed to the proximity of the shore on rafts.

No. 13.—In the thirteenth number the article is continued. The author discusses the defence of the Russian coasts in the Baltic and Black Sea. After deciding the manner in which they were defended when the defence was assisted by a high-seas fleet, he discusses the defence under present conditions when the fleet is practically non-existent. The defence must depend on land forces, coast fortifications, aerial fleet, mine fields and the assistance of any naval vessels, including submarines, which may be constructed before the outbreak of war. He quotes Sir Percy Scott and other naval officers to show the immense value of the modern submarine. Having briefly outlined the coast defence systems of France and Italy, he proposes a scheme for the defence of the Black Sea coast under present conditions. In the absence of a high-seas fleet he reckons that six Army Corps and four fortified bases would be required, and dwells, at some length, on the questions of communications, roads and railways.

No. 14.—In this number he completes his long article. He lays great stress on the value of the aerial fleet and on the advantages which the defence has in this respect, owing to the propinquity of its aerial base. He describes the advantages and disadvantages of artillery on railway mountings, and emphasizes the importance of properly organized mine defence, giving some account of the mine-fields in the North Sea. He then deals with the distribution and action of land forces and machine-guns; to illustrate the importance of the latter, he shows how the silencing of a machine-gun at Kum Kale greatly facilitated the French attack. He finally adds some remarks on the organization of command and responsibility. After reviewing the systems of different countries he comes to the conclusions: that countries with large land frontiers have been obliged to hand over coast defence to the Admiralty Department; that there must be officers of the air force and general staff of the Army on the naval coast defence staff; that when an extensive landing takes place, operations will have to be entrusted to an Army commander.

A.H.B.

THE MILITARY ENGINEER.

July–August, 1924.

Super-power and its Public Relations. By the Hon. Herbert W. Hoover.—The Secretary of Commerce reviews the progress of electrical generation and distribution. The perfection of high voltage, long-distance transmission and improvement in generating machinery now make possible the development of cheaper power from water sources further afield and from coal stations more favourably placed. The essence of super-power is inter-connection, which conveys the advantages of a better average load factor through pooling the effect of day and seasonal variations, and more security in power supply against strikes, whilst enabling stations to reduce the amount of reserve equipment. The development of super-power will depend primarily on the attitude of public bodies. Free flow of power across state boundaries is essential. The economic distribution of power rests to a large extent upon local territorial monopoly, which implies a measure of public regulation. The writer believes that the problem will find its solution in co-ordinated state regulation, with, perhaps, the assistance and co-operation of the federal government.

Motor Transport in War.—The Army has recently adopted the principle of pooling. The allotment of vehicles to units is limited to the immediate needs of the command to which they belong, the remainder being pooled in corps or larger units as required.

The writer discusses the effect of these changes and their possible influence on the future organization of M.T. Companies.

R.I.M.

CORRESPONDENCE.

TIDES.

To the Editor, *R.E. Journal.*

SIR,

As you invite criticism of Mr. Louis Stromeyr's tidal theory, may I say that I agree with him that the tidal ellipsoids are due to distortion of the spheroid. But this is caused by the moon's attraction interfering with the equable pressure of terrestrial gravity and the wave is caused by the rapid shifting of the lines of pressure, due to rotation continually changing the face presented to the moon. This is the theory put forward by Moxly 26 years ago and has never been refuted.

The equilibrium theory was one of the first-fruits of Newton's theory of universal gravitation, and was only abandoned because, with the Earth rotating and the moon revolving, as in Nature, the currents assumed necessary to keep the vertices under the moon were found to be absolutely impossible (1,000 miles an hour along the Equator).

It also seemed contradicted by the tides of the Channel, which I have shown elsewhere* are largely (and when the moon is over the equator almost wholly) due to a *derived* wave from the Southern Ocean.

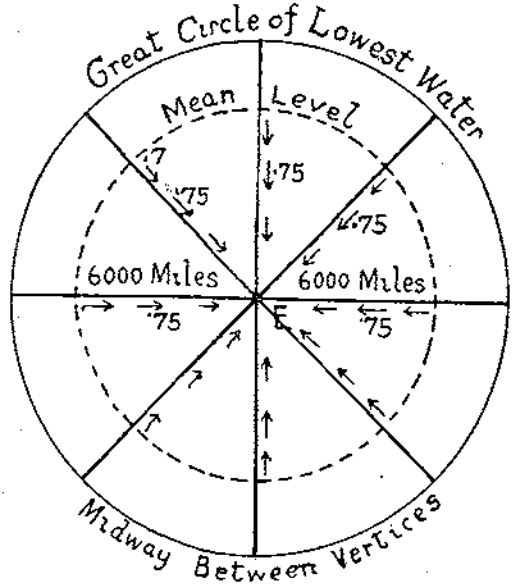
The dynamical theory which replaced it agreed better with the tides of our home waters, but was later found to be hopelessly inadequate to account for the tides of the Great Southern Ocean, where alone they have the chance of behaving as on the ideal world covered completely with a deep envelope of water, and for such *so-called* "anomalies" as single-day tides. But for want of a better, it remained the received theory of the world until Moxly showed that tidal force *could not produce current and must generate pressure* towards the point under the moon.

It is, I believe, universally admitted by mathematicians that it is the tangential component of tidal force that is the great tide raiser. Now whilst this varies according to distance from the vertex, it operates upon every particle in every line from the great circle of lowest water, 90° distant, to the vertex, and in every layer of water from the surface to the bottom of the ocean, so that the pressure is cumulative, or integrated in every line, just as it would be in a column of weights 6,000 miles high, where all is concentrated at the bottom, diminishing to zero at the top.

Now as all the lines of pressure meet under the moon there can be no relative motion, but a rise of level until the weight of water raised balances the pressure, when equilibrium results. But, as rotation changes the face presented to the moon, the whole system moves, producing the tidal wave by the shifting of the lines of differential pressure which originally produced the protuberance. As the wave has a length of 12,000 miles along the equator and a height of only

* *Moxly's Theory of the Tides*, by J. F. Ruthven. Published by J. D. Potter, Admiralty Chart Agent, 145, Minories, London; and *The Nautical Magazine*, November, 1919, to June, 1920.

5 ft., it is, of course, invisible and the only indication of wave motion is the gentle rise and fall of 10 inches per hour, although the velocity is nearly 500 yards per second.



Sketch showing how the tangential component of tidal force is integrated from every point in the circle of lowest water through a distance of 6,000 miles to E, the spot under the moon (vertex).

If the moon's attraction was the only force in operation, the earth and moon would have crashed into each other centuries ago. The force that has prevented this catastrophe, and keeps them in their relative positions, is the centrifugal force of revolution. Whilst it exactly balances attraction the nature of the two forces is different. Centrifugal force has the same value for every particle of the earth, whilst attraction varies inversely as the square of the distance from the moon's centre. Thus the two forces are only equal on the centre particle of the earth, and on all particles which have this same distance from the moon. Attraction increases with diminishing distance, and builds up what is called an "overbalance" on the side of the earth facing the moon, raising the lunar tide which I have described. On the side remote from the moon attraction, gradually decreasing, allows centrifugal force to create in an exactly similar manner an "overbalance" which generates the anti-lunar tide.

With the moon over the equator, the crest running north and south through the 5 ft. vertex tapers away to mean level about the 55th parallels of latitude and thence to lowest water at the poles.

This theory is confirmed by observation of tides at islands in the Great Southern Ocean, such as Tristan D'Acunha, where at full and change the tidal crest is exactly where we place it, and as far removed as possible from the position assigned to it by the great French Astronomer Laplace, who, like Newton, was misled by the tides of our coasts.

I have explained elsewhere,* how when the moon is away from the equator, it accounts for diurnal inequality, single-day tides, highest H.W. preceding lowest L.W. on one side of an ocean, and following it on the other, and many other so-called "inexplicable anomalies" that encumbered the tide tables up to less than twenty years ago. The explanations are generally so simple as to be obviously true, and much too numerous to be fortuitous coincidences.

Yours faithfully,

J. F. RUTHVEN,
Ex-Commodore Orient Line.
(Moxly's Colleague).

EAST PERSIA.

To the Editor, *R.E. Journal.*

SIR,

I note that, in the September number of the *Journal*, your reviewer of General Dickson's book, *East Persia*, comments on the fact that there "are no descriptions of the methods adopted for the crossing of ravines and streams."

I have not yet read General Dickson's book, nor should I in any case presume to answer the criticism, but I was myself engaged on the work of helping to build General Dickson's road, and I would suggest that the reason why no mention is made of "Inglis bridges, steel girders, or suspension work," is simply that no such things existed within 1,000 miles, nor could they have been brought to the site even if they had been available.

In the section on which I was engaged we had ravines; also we had streams of the usual violently intermittent character; and in a country where there was literally not enough timber to make a door frame, and only just sufficient camel transport to keep the troops and a large army of coolies decently fed, the only possible method of tackling road construction across ravines was to carry the road down to the river bed, treat a wash-out as an act of Providence, and repair it, first temporarily, and then semi-permanently, after the rains had stopped, by making up the road once more solid.

Latterly one did attempt to put in properly laid Irish bridges, and in some cases culverts, if one happened to find suitable large stones locally. But these were totally inadequate to cope with wash-outs, and one always had to keep a large gang of coolies ready for essential and hurried repair work.

I do, however, agree with the reviewer in the respect that a detailed account of the engineering difficulties overcome on the L. of C. would form a valuable addition to R.E. knowledge as such. Not enough has yet been written on this subject.

My own native Field Company—at one time the only Works unit on the Line—with true adaptability, coped with such problems as

* *Moxly's Theory of the Tides*, and *The Nautical Magazine*, November, 1919, to June, 1920.

ranged between the carrying out of a water-to-water march of 48 miles in the blazing desert, and the providing of a blood-thirsty Havildar and two Sappers to lead the assault against the Bolsheviks.

I would pay a sincere tribute to General Dickson's driving energy in pushing his road through in such a marvellous manner.

I have the honour to be,
Your obedient servant,
A. PRAIN, *Captain, R.E.*

THE DECISION TO DEFEND KUT.

To the Editor, *R.E. Journal.*

SIR,

As I had already written an article in the *Army Quarterly* of April, 1923, on the subject of Townshend's decision to hold Kut, I should not have taken notice of Major Sandes' article in the September number of the *Journal*, had it not been for a remark that he makes on p. 428: "This Shumran position was recommended by the Brig.-General R.E." I would like to ask Major Sandes whence he got this information, as I was the Brig.-General R.E. at the time, and I certainly did not recommend anything quite so insane as to hold the Shumran position, which was in every respect worse than that of the Es-Sin Banks; in fact, it would have been quite untenable.

Whether Major Sandes had read my article on Kut-el-Amarah, referred to above, or not, I do not know, but his defence of the decision to hold Kut only strengthens my conviction that it was a terrible error, both strategically and tactically. At the same time, it must be understood that it was the Commander of the Mesopotamia Expeditionary Force who was to blame rather than his subordinate, Major-General Townshend.

I trust that the fate of Kut may be an enduring warning to every British Commander not to shut up a Field Force in a fortress or defended place.

Yours faithfully,
September 14th, 1924. J. C. RIMINGTON, *Major-General.*

The Editor, *R.E. Journal.*

Sir,

With reference to Major-General J. C. Rimington's letter regarding my article in the *R.E. Journal* of September, 1924, on the decision to defend Kut-el-Amarah, I trust that you will insert this reply to the criticisms expressed therein. When I wrote the article I had not had the privilege of reading General Rimington's article in the *Army Quarterly Magazine* of April, 1923, and, in fact, I was not aware that such an article had appeared. I hope that any views expressed by me in the *R.E. Journal* will not, therefore, be considered as being in deliberate opposition to those of General Rimington, whom I would have consulted if I had known the facts of the case.

I admit that the alternative position, No. 1, above Kut, shown on page 427 of the September issue of the *R.E. Journal*, was incorrectly drawn, and that it appears that I was in error in asserting that that position, as shown, was recommended by the Brig.-General R.E. (General Rimington). The position should have been shown as extending also on to the left bank, and I offer my apologies to General Rimington for this mistake and for my remark that he had approved the right-bank position. I wrote on page 146 of my book, *In Kut and Captivity*, as follows: "But if our force had been an army corps, instead of four weak brigades, it seems that a better position could have been occupied upstream of the town, *and chiefly on the right bank*, where the force could have fortified and held a loop of the river, placing the Tigris between it and the enemy as a natural obstacle to his advance." That statement was seen by General Rimington, who wrote to me on the subject and did not question its accuracy at the time. As General Townshend did not have an army corps, he could not have held the No. 1 position on both banks. The same remark, however, applies to the No. 4 position at Es-Sin. But it seems that the possibilities of the No. 1 position, extending on both banks, were actually investigated, though rejected.

General Rimington alludes to my article as "a defence of the decision to hold Kut." I had no such intention in writing the article, and I have not expressed that attitude intentionally in the article. I would refer him to page 431 of the September issue, where I have stated in my article that military opinion now inclines to the idea that, whatever the difficulties and losses, Townshend should not have defended Kut, and to page 432, where I have remarked: "I think, however, that our force would have been capable of resuming the retreat as far as Ali-al-Ghubi or even Amarah after three days' rest at Kut." On the same page, also, I gave four reasons why, in my opinion, Townshend's force failed to fulfil its proper rôle by remaining in Kut. I think that these extracts dispose of the contention that I defend the decision to remain in Kut. But, though I agree with modern military opinion that Kut should not have been defended, I think that General Townshend was placed in a very unfortunate predicament, and I have tried, in my article, to examine impartially the factors which presumably induced him to remain in Kut, for they form an interesting study.

Yours faithfully,

E. W. C. SANDES, *Major, R.E.*

ERRATA.

R.E. Journal, September, 1924.

The Photograph opposite page 382 was by Messrs. R. B. Holmes & Co., Peshawar.

Page 396, line 14, *for* "supplied," *read* "sufficed."

" 399, line 36, *for* "translations," *read* "transactions."

" 400, line 41, *after* "cartography," *insert* "had."

" 493, line 42, *for* "Military Engineering," *read* "Estimating and Construction."

" 508, line 8, *for* "W.P.P.-W." *read* "R.P.P.-W."

PRINCIPAL ROAD COMMUNICATIONS ON THE N.W. FRONTIER OF INDIA.

SCALE: 32 MILES TO 1 INCH.

Miles 10 6 0 10 20 30 40 50 60 70 80 90 100 Miles.

REFERENCES.

- Metalled Roads
- " " under Constn.
- Partially Metalled Roads.
- Unmetalled Cart Roads.
- Pack Roads.
- Broad Gauge Railways.
- Narrow. " "
- Boat Bridge. B.B.
- Ferry. F.