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

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## THE INSTITUTION OF ROYAL ENGINEERS.

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## SPECIAL NOTICE.

**The fact that goods, made of raw materials in short supply owing to war conditions, are advertised in this magazine should not be taken as an indication that they are necessarily available for export.**

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2,300—1.3.42.

H.R.H. Prince Arthur.
Lieutenant, Royal Engineers, 19th July, 1868, to 2nd November, 1868,
from a photograph presented to
Major-General (later Field Marshal Sir) J. L. A. Simmons, C.B., Royal Engineers,
by H.M. Queen Victoria, 1868.

**HRH Prince Arthur.**

## *FIELD-MARSHAL H.R.H. THE DUKE OF CONNAUGHT AND STRATHEARN,*

K.G., K.T., K.P., G.C.B., G.C.S.I., G.C.I.E., G.C.V.O., G.B.E., V.D., T.D.

No Sapper listening to the wireless on January 16th who heard the first brief announcement of the death of that beloved Royal Prince and Great Gentleman, the senior officer in the British Army, can have failed to feel a thrill of pride at the words "The Duke of Connaught began his military career in the Royal Engineers." His long life belongs to the history of our country, and it is the privilege of the Corps that for a short time he was a subaltern at Chatham. Not only when commanding a battalion in peace or a brigade in war, and when Commander-in-Chief at Aldershot or Inspector-General of the Forces, but also when as a Field-Marshal he represented his Sovereign as Governor-General of Canada, and in State Missions to South Africa and India, he was always regarded by the general public as pre-eminently a soldier.

It seemed that Fate destined him for the Army from the day of his birth, May 1st, 1850; for this was also the 81st birthday of the Duke of Wellington, who was his Godfather and whose name Arthur he received at his christening. There is some evidence that Queen Victoria's decision to select our own Corps as the one in which her third son should be first commissioned, may have been due in part to the influence of the Great Duke himself. Prince Arthur was still an infant when his illustrious Godfather died, but it is probable that the Duke, in his conversations with the Queen and the Prince Consort, had often referred to the Engineer officers who had served him so well in the Peninsular War. The *Royal Warrant* authorizing the R.E. Establishment at Chatham in 1812 was directly due to the Duke of Wellington's representations to the Government after the Siege of Badajoz that year, as to the importance of having "a corps of sappers and miners formed without loss of time." There had hitherto been no technical troops to help the Royal Engineer officers to carry out siege operations, bridging, or construction of defences; and it is easy to imagine Wellington's appreciation of their skill in organizing—to quote an outstanding example—the Lines of Torres Vedras with unskilled labour. There can be little doubt that the Duke's personal interest in military engineers and their work lasted for the rest of his life.

Soon after the Crimean War, where the sappers and miners earned great distinction, the C.R.E. at the capture of Sebastopol, Lieut.-General Sir Harry Jones, recommended his adjutant, Lieutenant J. C. Cowell, to the Prince Consort, as "Governor" to his second son, Prince Alfred (later Duke of Edinburgh). According to a letter from Queen Victoria to the King of the Belgians in 1860, it is evident that this appointment was very satisfactory. Not unnaturally, perhaps, the Royal Engineers were called upon again when the time came for a "Governor" to be chosen for Her Majesty's third son, and Major H. C. Elphinstone, V.C. was selected; Prince Arthur was then eight years old. This appointment also was a great success, and both these Sapper officers retained the confidence and affection of the Royal House to the end of their lives; Major-General Sir John Cowell eventually became the Queen's Private Secretary.

Prince Arthur entered the Royal Military Academy in February, 1867, shortly before his 17th birthday. During an 18 months' residence he carried out drills and exercises with the other cadets, took his regular turns of duty, accompanied his class to Shoeburyness for gun practice, and underwent some separate and special studies. It is recorded that his "strong personality and unaffected manners gained him great popularity at the 'Shop.' He was always smartly turned out, his uniform was invariably spotless, and the keenness with which he carried out any military duties greatly impressed the authorities."

On June 19th, 1868, he passed out into the Royal Engineers. By a curious chance the only other officer who has been so long on the active list (over 73 years) Field-Marshal Sir John Burgoyne, the first Engineer to reach that rank, relinquished the appointment of Inspector-General of Fortifications in the same year that Prince Arthur received his commission. Of both men the words engraved on the base of the Burgoyne statue in Waterloo Place have a real and literal meaning:

> "How youngly he began to serve his country:
> How long continued!"

The Prince's association with the "Shop" was marked in 1871 by the presentation to the Library by the Queen of a bust, modelled by Princess Louise. Many years later, shortly after the outbreak of the South African War in 1899, the former Cadet made a special visit to Woolwich to unveil four memorial windows in the dining-hall; each window contained two portraits—Queen Victoria and the Prince of Wales (King Edward VII), the Dukes of Connaught and Cambridge, Lord Roberts and Sir Richard Dacres (C.R.A. in the Crimea), and two Sapper Field-Marshals, Sir John Burgoyne and Sir Lintorn Simmons. The last-named, 30 years senior to the Duke, was Commandant of the S.M.E. in 1868 and had just reached the rank of Major-General. Lord Napier of Magdala, the second officer of the Corps to receive a Baton, was ten years older than Simmons, and had recently returned from his victorious campaign in Abyssinia.

Amongst Prince Arthur's near contemporaries were Sir Richard Harrison, Sir Charles Warren, Sir John Ardagh, Sir Bindon Blood, Lord Nicholson of Roundhay, Sir Herbert Chermside, Sir Reginald Hart, and Lord Sydenham of Combe (one of the creators of the Army Council in 1904) who joined the Corps one month after His Royal Highness. Lord Kitchener of Khartoum, though not commissioned until 1871, was actually born in the same year as the Prince, 1850. Charles Gordon was of an earlier generation than any of the above, and was 35 when the Prince received his commission.

While at the S.M.E. the Prince went through a short course of instruction in the more strictly military part of engineering work, including assault operations and bridging. The portrait of H.R.H., published with this *Journal*, is taken from a coloured photograph presented in an ornamental frame to the Commandant by the Queen when the Prince left Chatham. The group also reproduced was evidently taken on the occasion of a gathering of senior R.E. officers assembled in his honour; it contains the three Field-Marshals mentioned above, and the Prince's former "Governor" Sir Howard Elphinstone, V.C.

Prince Arthur was transferred to the Royal Artillery in November, 1868, and thence to the Rifle Brigade in 1869, with whom he saw his first active service, —the repulse of the Fenian raid in Canada in 1870. After five years with them, he joined the 7th Hussars (his son's first regiment a quarter of a century later), with whom he served two years before rejoining the Rifle Brigade and commanding the 1st battalion. He was created Duke of Connaught in the Birthday Honours of 1874. He now possessed an intimate and personal knowledge of the tactics and organization of all arms, but he was always first and foremost a Rifleman; while our own Corps has long had the privilege of printing his name in the *R.E. List* at the head of those "officers (now serving) who have transferred to other arms of the Service." The Duke commanded the Guards Brigade at the Battle of Tel-el-Kebir in 1882, where his conduct earned the high praise of Sir Garnet (later Viscount) Wolseley.

A striking feature of the Duke of Connaught's career was his friendship with all ranks. He was as much at home with the cadets at Sandhurst as with the many officers attending Staff College reunions at Camberley, where his remarkable

*Back Row*—Major H. Wray; Lt.-Col. P. M. N. Somerset; Major H. C. Elphinstone, v.c.; H.R.H. Prince Arthur; Maj.-Gen. H. O. Harness
Col. W. O. Lennox, v.c.; Capt. B. Brine, Adjt.; Capt. R. H. Stotherd; Gen. Sir J. M. F. Smith, k.h.; Major R. Harrison.
*Front Row*—Maj.-Gen. J. L. A. Simmons; — Lt.-Gen. Lord Napier of Magdala; Gen. Sir J. F. Burgoyne; Sir F. Head, k.c.h.
Maj.-Gen. Sir J. W. Gordon; — Maj.-Gen. F. A. Yorke.

**Group photograph, opposite p 2**

memory for faces had full scope. He seemed more the very senior officer than the Royal Prince, and preferred to be addressed as "Sir" rather than "Your Royal Highness." Recollections of distinguished soldiers of generations later than his own refer not only to his courtesy and consideration, but also to his continual search for improvement and reform; it is no mere legend that credits him with the introduction of khaki into the Army. Amongst innumerable examples of his thoughtfulness for others, may be mentioned two when he was Commander-in-Chief at Aldershot. In 1897 he instructed the C.R.E. to make special efforts in the renovation of certain quarters for his D.A.A.G., Lieut.-Colonel Herbert Plumer; and in his farewell speech in the R.E. Mess at Stanhope Lines in the following year he referred to the high standard of the Mess, and to the economy practised in it, an economy by no means the rule in those days.

To the Duke's great regret he was not allowed to take part in the South African War, but he continued to wield great influence in the Army as Commander-in-Chief in Ireland. He paid a special visit to Brompton Barracks in July, 1905, when Inspector-General of the Forces, on the occasion of the unveiling by King Edward VII of the Corps Memorial to their comrades who had fallen in that war. The senior serving Engineer officer present was Sir William (afterwards Field-Marshal Lord) Nicholson, just returned from the post of Chief British representative with the Japanese Armies in Manchuria, and later to become Chief of the Imperial General Staff. The junior officer who figures in a photograph taken after the ceremony was Lieutenant A. E. Davidson, now a Colonel Commandant. It may be noted here that H.R.H. himself unveiled the Corps Memorial at Chatham after the Great War, in 1922.

Two Chiefs of the Imperial General Staff during the Great War, Sir William Robertson and Sir Henry Wilson, both received considerable encouragement from the Duke at various stages of their careers. His Royal Highness visited the British troops in France on more than one occasion; and sent a special telegram of congratulation after the Battle of Messines in 1917 to Sir Herbert (later Lord) Plumer, "as an old chief of yours." He spent some days with the Army of the Rhine at Cologne in May, 1919, and had the opportunity of seeing three battalions of his own Rifle Brigade. Another Chief of the Imperial General Staff, Sir George (later Lord) Milne, had the honour in June, 1928, of offering the congratulations of the Army Council on the Duke's Diamond Jubilee in the Army. In the following year he celebrated his Silver Jubilee as Colonel of the Grenadier Guards, and in 1930 his Golden Jubilee as Colonel-in-Chief of the Rifle Brigade.

We turn from his military to his civil services to the State. From 1911 to 1916 the Duke was Governor-General of Canada, where he and the Duchess were universally loved and respected; in the words of *The Times* "he was the direct expression of the Throne to the statesmen and people of Canada." The Canadian troops in their training camps regarded this "real soldier" as they called him, with special pride and affection. Some of them, and their sons were again inspected by the Duke, then in his 90th year, at Aldershot in 1940. Very soon after T.R.H.'s. return to England the Duke suffered the grievous loss of his wife. Thirty-eight years of happy married life had elapsed since that day in March, 1879, when he and his bride drove from St. George's Chapel at Windsor to Claremont. The boys of Beaumont College assembled at the gates and cheered wildly as the carriage drew up to receive the address they presented to the Duke and Duchess.

In two other Dominions the Duke of Connaught performed State Missions of the highest importance with conspicuous success. He opened the first Parliament of the Union of South Africa (where his son was later Governor-General) in 1910; and the new Chamber of Princes and reformed Legislature at New Delhi in 1921. He had already visited South Africa in 1906, as Inspector-General of the Forces; and had actually served for seven years in India, including the command of two divisions and of the Bombay Presidency, besides attending the Durbar to announce King Edward VII's Accession. His popularity in India in every class of society was equalled by the admiration of the Indian Army, in which he was always greatly interested; a number of Indian units have the distinction of being "The Duke of Connaught's Own" (D.C.O.). His mission to India in 1921, in view of the difficult constitutional problems involved, and the generally hostile political atmosphere, was considered by many to be the crowning achievement of his career.

The Duke had travelled widely; he was a well-known figure on the Continent, and had also been to Egypt and Palestine. As long ago as 1890 he came home from India *via* the Far East, and spent a short time in Hong-Kong. The G.O.C. was Major-General Sir James Bevan Edwards, a Crimean and Indian Mutiny veteran and a distinguished R.E. officer, who had been Commandant of the S.M.E. until the previous year. Sir James was also administering the Government, as the Governor was away on leave, and had the privilege of entertaining the Duke. Our senior Colonel Commandant, Sir George Macdonogh, was commanding the Hong-Kong Company of the R.E. at the time, and was one of those presented to H.R.H. at the Reception held at Headquarter House. The Duke also paid a short visit to Japan, then a comparatively unknown country; he can have had little idea that his son was destined to carry out three State Missions to that distant land during the days of the Anglo-Japanese Alliance—the first, in 1906, to invest the Emperor Meiji with the Order of the Garter.

It was inevitable that the Duke of Connaught should have many other tasks to perform in addition to his duties to the State. A complete list of all the patriotic, benevolent, educational, learned, and artistic Societies and Institutions of which he was the vigorous Patron or President would fill many pages. In his own person he represented as no other subject of the King could do, all that was fine and noble in our national life, and that enhanced the "safety, honour, and welfare of our Sovereign and his Dominions."

From a great array of activities, to all of which H.R.H. brought no formal or perfunctory participation, but dignity, wise counsel, and ready sympathy, his Presidency of the Royal Empire Society and of the Royal Academy of Music have been specially noticed in published tributes; they are but two illustrations of the widely differing objects to which he lent not only his name, but real human interest and enthusiasm. Reference must be made here to his Presidency of Wellington College, whence so many boys have entered the Army—some of whom he saw again at his frequent inspections of the Royal Military College, Sandhurst. He presided on one or more occasions at Speech Days of other Colleges, notably of the two oldest Victorian Public Schools, Cheltenham and Marlborough; the former was founded when his Mother had been only four years on the Throne, and for many generations maintained a friendly rivalry with Wellington as regards the number of annual entries into the Royal Military Academy, Woolwich.

The Royal School at Bath for the daughters of officers of the Army was also fortunate in having the Duke as President for 37 years. He always took the keenest interest in the School, presiding at several annual meetings, and laying the foundation-stone of the Memorial Wing. Quite recently he wrote a personal letter of thanks to an American citizen who has been a munificent benefactor of the School.

No estimate is possible of the amount of good that resulted from the Duke's influence in so many and diverse fields. Provided he was satisfied that the cause was worthy, nothing deflected him from giving it his full support, however great the inconvenience. It is said that he never left a letter unanswered, and invariably acknowledged all birthday and other congratulations. His sense of duty, in great things and small, was one of his most outstanding characteristics.

* * * * *

The announcement of his death in the Court Circular, reads as follows: "The

King and Queen have received with great sorrow the news of the death of Field-Marshal His Royal Highness The Duke of Connaught, Great Uncle of His Majesty."

This venerable relationship takes our thoughts far into the past, and gives an opportunity of looking back through many years of the history of England. We may reflect that the Duke's own Great Uncle, King William IV, the "Sailor King," who was succeeded on the Throne by his niece, Princess Victoria, died on June 20th, 1837. The King, to quote Justin McCarthy's *History of our Own Times*, "had himself attended since his accession the Waterloo banquet (June 18th); but this time the Duke of Wellington thought it would perhaps be more seemly to have the dinner put off, and sent accordingly to take the wishes of His Majesty. The King declared that the dinner must go on as usual, and sent to the Duke a friendly, simple message, expressing the hope that the guests might have a pleasant day. . . . He had his despatch-boxes brought to him, and tried to get through some business with his private secretary . . . the last official act he ever performed was to sign with his trembling hand the pardon of a condemned criminal."

Duty, human kindness, consideration, and mercy—English qualities as we like to think, and nowhere more observed than by our Royal House, and by the Prince of that House who has just entered into his well-earned Rest.

The Duke's second daughter, Lady Patricia Ramsay, was with her father at the end. His elder daughter, Princess Margaret, wife of the Crown Prince of Sweden, died in 1920, three years after her Mother; and his only son, Prince Arthur of Connaught, Colonel-in-Chief of the Royal Scots Greys, in 1938. The Earl of Macduff, only child of Prince Arthur, born in 1914, succeeds to his Grandfather's Dukedom.

At the funeral at Windsor on January 23rd, seven Field-Marshals were Pall-bearers, and the Corps to which he once belonged was represented by the Chief Royal Engineer, Lieut.-General Sir Ronald Charles. Major-General G. H. Addison, Representative Colonel Commandant, acted in the same capacity at the Memorial Service at Westminster Abbey on January 30th. The Sapper subaltern of 1868 retained a definite connection with his first Corps: in 1906 he became the first Honorary Member of the R.E. Institute, and he was Vice-Patron of the R.E.O.C.A. at the time of his death.

F.S.G.P.

# THE "NIGHT HAWK."

*By* CAPTAIN A. C. COOPER, R.E.

"I WANT you to make a railway engine," said the C.R.E., "to pull at least one loaded truck up the hill."

"What shall we make it from, sir," we said.

"Whatever you can find and you can use any suitable captured enemy material."

This conversation took place about the beginning of March, 1941, on the road between Agordat and Keren in Eritrea.

The Italians had been on the run since we had re-occupied Kassala in January.

Rearguard actions had been fought at Wachai and Keru; a fair resistance being put up at Agordat. At the beginning of March, the Italians were holding a position of great natural strength on the hills surrounding Keren, while the troops on our sector were facing the enemy on slightly lower hills to the S.W. of the town.

Our greatest difficulty at that time was "supply" for there were two brigades on the hills 2,000 ft. above and about 12 miles from the nearest point to which M.T. could approach. The supply problem would have been almost insurmountable, had there been no railway line. Fortunately, the Agordat–Keren line, climbing from the plain up to the Keren plateau, ran close to the rear of our positions on the hills.

The only railway in Eritrea runs between Massowa–Asmara–Keren–Agordat and is a single line with a bastard gauge of 95 cms. The maximum grade is $3\frac{1}{2}\%$ and the sharpest curve has a radius of 30 metres. These severe conditions exist for practically the whole of the climb up to Keren and combine to make the ascent a difficult one.

The Italians had made two attempts to block the line; one in a tunnel and the other in a cutting. The method was the same in each case. The track was removed for two rail lengths and a train of about 15 wagons loaded with stone was allowed to run down the incline and derail. Had we engines and wished to make immediate use of the railway, these blocks would have imposed only slight delay. The wagons were soon cleared and, on balance, we were several serviceable and repairable wagons to the good; one of which eventually became the "Night Hawk."

The transport of supplies to the forward troops was made an engineer responsibility and a train service of 6 flat wagons was arranged to run twice daily. Each wagon was hauled by a 15-cwt. truck running astride the track, and on reaching the terminus on the hills, the truck reversed up a ramp on to its flat wagon and the whole ran back down the hill in charge of a brakesman. This service could only run by day, as the truck driver had to see where he was going, and was sufficient for daily supply of the troops. To enable reserves of water, food and ammunition to be built up preparatory to the final assault on Keren, some method of supply by rail at night became essential. Hence the urgent need for a power-driven loco.

The manufacture of a locomotive in the field is not a job which often falls to a Divisional Field Park Company, whose machine tools are one power drill and a 7-inch lathe. This article describes how it was done.

Our first effort was to convert a captured S.P.A. lorry to run on rails. The front road wheels were removed and the front axle was U-bolted down to a 2-axle trolley, allowing sufficient play for negotiating curves. So much for the front end, but the crux of the problem was how to arrange the final drive from the engine to rail-wheels. As the track of the S.P.A. lorry was considerably more than 95 cm., we cut down the back axle casing and half shafts and fitted trolley wheels instead of road wheels. Mark I worked for a short time, but could not have lasted long, as we did not have time to fit efficient oil retainers and ball races to the back axle casing. Grip on the rails was not good, due to the smallness of the wheels and lack of weight; the model eventually failed, due to buckling of the wheel flanges when the chassis was overloaded in an effort to increase the adhesion.

Accordingly, it was decided that a chain and sprocket was the only satisfactory arrangement for the final drive. But where could we find some chains and sprockets? Salvage dumps were searched, junkyards and garages in Agordat were

"The Night Hawk"

inspected and even a gold mine near the Abyssinian border was drawn—but there were no chains nor sprockets.

Eventually a derelict lorry was found within a few hundred yards of Div. H.Q. Clearing away the bushes, we discovered an incredibly old Fiat lorry with solid rubber tyres, but—it had chains and sprockets for its final drive. So we towed the derelict away and got down to work. This Fiat had a gearbox mounted rigidly on the chassis some 6-ft. behind the clutch. A shaft, with a multi-disc type flexible coupling at either end, brought the drive from the clutch to the gearbox. The differential assembly was bolted direct to the gearbox, with open half shafts either side to the driver sprockets. The half shaft bearings were mounted on the chassis, and the chains went down at an angle of 45° to the driven sprockets, which were bolted to the inside of the rear road wheel spokes. We decided to mount the Mark I S.P.A. engine and Fiat chain drive on to a 12-ton railway wagon.

The first job was to remove one axle and wheels from the wagon and take off the driven sprockets from the lorry—and fit one to the other. It was essential that the sprockets were firmly and centrally fixed to the rail wheels. Owing to the peculiar saucer shape of the web of the wheels, a special wedge-shaped washer had to be made for each bolt; the washer being between the sprocket and the rail-wheel. There were sixteen of these washers and each had to be rough forged, filed to fit and drilled.

Having fixed the driven sprockets, we measured the distance between the two; the driver sprockets had to be the same distance apart.

We also decided that the best way of fixing the Fiat gear box was to cut out that part of the Fiat chassis on which the gear box was mounted and bolt that down to the railway wagon frame. Owing to shortage of welding gas and hacksaw blades, this had to be done by cold chisel. From the measurements, we found that the driver sprockets had to be brought about 2" nearer to one another. We shortened on one side only, having to shorten the Fiat chassis cross members as well

"The Night Hawk."

as one half shaft. The driver sprockets were keyed on to the ends of the half shafts, which were tapered.

As time was pressing and to avoid turning to a taper and cutting a new key-way, we decided to shorten the half shaft by cutting it and turn down one piece to fit inside the other, which had been drilled to receive it. It was arranged that the strength in torsion of the turned-down part was equivalent to the strength in torsion of the other part taken as a hollow tube. The joint was pinned to prevent turning; and the size of the turned-down part was about 1" diameter.

We were now ready to mount the Fiat box on to the wagon frames. Special long bolts had to be made and the chain tension was adjusted by putting wooden blocks of the required size between the Fiat chassis frame and the wagon frame. As the driver sprockets were almost vertically above the driven sprockets, no great load could be taken on the "Night Hawk" itself without compressing the wagon springs and loosening the chains; but bulky loads of personnel or mule fodder were carried satisfactorily. Mounting the S.P.A. engine and chassis from Mark I presented no difficulty and the next problem was to connect the propeller shaft to the Fiat box.

The S.P.A. had a heavy tubular propeller shaft with a full universal joint at either end. Owing to the height of the S.P.A. chassis above the Fiat box, the prop. shaft had to come down at a fairly sharp angle and it was found that some sort of bearing was essential to position the shaft at the point where it straight-

**The 'Night Hawk' p 8**

ened out parallel to the wagon frame to connect to the Fiat box. Accordingly the bearings and thrust races were withdrawn from the S.P.A. differential casing and fixed in a rigid bracket on to the wagon frame in front of the Fiat box. The bevel pinion was removed, and the short shaft was turned to a taper and keywayed to fit a spider from the Fiat lorry. This spider was connected to the spider already on the Fiat box by bolting to a number of steel rings.

Thus the drive came from the S.P.A. engine and gear box, through a universal joint to the prop. shaft, through another universal joint, through a positioning bearing, through a flexible coupling and into the Fiat gearbox.

Each box had four forward speeds and a reverse; so we had 17 forward speeds and 8 in reverse. Later we found the best combination for hauling up the hill to be 3rd gear in both boxes. Although great care was taken to align the drive correctly, we had some trouble at first due to the prop. shaft tending to run eccentrically. Eventually we discovered that when a heavy prop. shaft has a full universal at both ends, it is essential to insert the splines so that the members of the universals are matched and parallel to one another. After doing this we had no more trouble.

We were now ready for the maiden trip. The "Night Hawk" got under way like an underground train, but after a mile came to a disappointing stop. The half shaft had failed owing to torsion at the point at which we had shortened it. However, after 24 hours' continuous work, a strong sleeve had been turned to cover the joint and both parts were securely pinned; the "Night Hawk" was again ready for the road.

The first trip up the hill took place on March 9th and the writer had the privilege of being O.C. train on that auspicious occasion. The "Night Hawk" pushed another truck loaded with 1,500 galls. of reserve water and left the loading station on its 10-mile climb around 21.00 hrs. It must have been a comical sight as we ground our way up the hills; the exhaust soon became red-hot and showered sparks; there was the screech of wheel against rail on the curves, the clatter from the chains and the roar from two very worn gearboxes.

About threequarters of the way up there was nearly a disaster, but luck was with us. The look-out man gave a sudden warning shout, but too late to stop us, and we crashed and lurched across an obstruction. We pulled up and found both wagons still on the rails, having jumped an 18" gap in one rail, which had been neatly removed by an Italian shell. The gap was in the outside rail of a curve, below which there was a drop of some hundreds of feet. The "Night Hawk" was undamaged and we went on to discharge our water, coasting back down the hill as soon as the track had been repaired.

After the first trip it was found that the bolts of the flexible coupling had almost sheared; so they were replaced by high tensile bolts and there was no further trouble.

On March 10th and 11th, Major E. Waring, R.E., then O.C. Company, and Lieut. R. H. Eagan, A.I.R.O., respectively were O.C. "Night Hawk;" on both nights two trips were made. These trips were not so eventful as the maiden trip, though the Italians were shelling the railway track intermittently on both nights.

Thereafter, the "Night Hawk" ran every night until the fall of Keren on March 27th; always two trips a night and sometimes three. No records exist of the exact number of trips, but we think 40 is a fair figure. With a pay load of 7½ tons on each trip, the "Night Hawk" carried 300 tons of supplies to our forward troops and ran 800 miles with no mechanical fault.

Before leaving Eritrea we heard that two steam locomotives for 3' 6" gauge (Sudan Railways) had been found in the heavy railway workshops in Asmara. The Italians had had the foresight to prepare these two locos., in case they should ever advance into the Sudan and require to use the Sudan Railways.

The "Night Hawk" now stands on a siding in a station near Keren having served her purpose; retired from service but not forgotten by those who built her.

## *GERMAN ENGINEER LANDING COMPANIES IN* 1914-18.

*By* BRIG.-GENERAL SIR JAMES EDMONDS, C.B., C.M.G., *p.s.c.*†, D.LITT.

IN the account of the landing on the Oesel Island, now again in the picture (see the *Army Quarterly* of July, 1925, " A German Landing "), and of the passage of the Danube and Save, a preliminary of the invasion of Serbia (see *The R.E. Journal* of September, 1941), mention was made of an engineer landing company (short title *Pilako*). The British army, which has carried out so many landings—and re-embarkations—has never considered it necessary to raise special units of this kind, so such particulars about them as can be gleaned, mainly from the German *Engineers Book of Honour*, may be of interest. Why the landing of troops was not left to the Navy has been explained in *Unsere Pioniere im Weltkriege*, issued by the General Inspector of the Engineer and Pioneer Corps and Fortresses. It is:

> " A purely seaman organization was not sufficient; for the safe passage to shore of heavy barge-like vessels, laden with horses and vehicles, posed technical propositions which only trained engineer forces could solve."

Seamen, it must be remembered, were none too plentiful in the German Navy: there were never enough of them; the crews of warships were usually made up of about one-third seamen, one-third river bargemen and one-third landsmen.

The 9th (Schleswig-Holstein) Engineer Battalion had practised landing operations before the Fourth German War (1914-18), and at the end of August, 1914, its depot (*Ersatz*) battalion received orders to develop this branch of its work. The matter was handed over to a company which was training on the Elbe at Oevelgönne.

A beginning was made by repairing the unserviceable landing apparatus, such as floating landing-stages, piers, towing barges, horse boats and surf boats (*Brandungsboote*). In October a further order was received to form a whole engineer landing battalion of five companies, and on the 1st November, companies drawn from the depots of the 2nd, 4th, 9th, 10th and 28th Engineer Battalions were assembled. Each company was housed on an ocean-going steamer. Exercises were carried out first near Krautsand and then at Brunsbüttel (at the western end of the Kiel canal). The boisterous November gales gave ample opportunity to test and improve the landing apparatus and gain a good deal of experience in its use. The general principle was that flat-bottomed boats would be towed landwards by steam or motor launches as far as the draught of these latter permitted, and would then be hauled ashore by hand by means of standing steel cables, the sea ends of which would be made fast to mooring buoys laid for the purpose, and the land ends to holdfasts.

On the 22nd December, 1914, report was made to the Supreme Command that the battalion was fit for service. But that august body had for the moment lost interest in landing operations—the idea of landing troops in the Baltic behind the Russian front had been abandoned—and gave orders for the dissolution of the battalion and the return of the companies to their garrisons, only a small staff for experimental work being retained. A month later the 9th Depot Battalion received instructions to inspect steamers for an oversea expedition. This was done, apparently, quite independently of the Admiralty, and a number of barges were purchased. On the 9th May, however, a full dress conference was held at the Ministry of War, at which were represented the General Staff, the Admiral Staff, the Sea Transport Department, the Inspector-General of Engineers, the Engineer Committee, and the 9th Engineer Battalion, for the purpose of considering an expedition to Russia. Amongst other things it discussed the early organization and training of an engineer landing company. Six days later a new company was formed by the 9th Depot Engineer Battalion, the earlier one having been sent to the Western Front as the 87th Reserve Company. It was first trained at Cranz, on the Elbe, then sent by steamer to Krautsand and later to Neufahrwasser (Dantzig). In the autumn, when the offensive against Serbia was being planned, it was thought that the passage of the Danube would provide a good opportunity to test the capabilities of the personnel and material of the company. They fully came up to expectation and, as related in the article on the "Passage of the Danube and the Save," the launches and barges of the landing company were the only vessels which could carry on in the rough water caused by the *Kosava* wind. After the campaign the company was left on the Danube, with headquarters at Braila.

Two years then passed until, on the 10th September, 1917, the 9th Depot Engineer Battalion received a telegram from the Staff, asking that an officer with experience in pier-building should report to the Sea Transport Department next day. The matter in hand was an expedition from Libau to Oesel Island and the construction of the necessary landing-piers therefor. No details of the nature of the shore, tides, depth of water and such-like were available, or could be obtained; so the scheme had to be based on normal conditions. Calculations were made for the personnel and material for a 100-metre run of heavy pier without floating supports—for pontoons and barges could not for lack of space be carried on the limited number of transports.

The Supreme Command was requested to send the Engineer Landing Company from Braila, even without its material, and this was arranged, but as embarkation was ordered to take place at Hamburg before 12 noon on the 18th September, it could not arrive in time. Three engineer companies of a strength of 4 officers, 17 N.C.O's and 160 sappers each, were therefore improvised from instructors, convalescents and recruits by the 9th Depot Engineer Battalion. The necessary material was purchased in Hamburg or sent there and, with the personnel, it was put, evenly divided, on two cargo steamers, so that if one were lost landing work could still go on. The steamers left Hamburg on the 19th. On the voyage round to Libau the material was sorted up and arranged so that it could be towed ashore. Considerable delay then occurred in the start of the expedition.

In the inter-services conferences which had taken place it was discovered that the Navy had not sufficient ratings for working the ships' cranes and winches or for manning the boats at the disembarkation. For the first purpose the commander of the expedition ordered one of the three engineer companies to be divided up among the 17 ships, in spite of the protests of the battalion commander that this would delay the construction of landing-piers. He offered the services of the other two companies for rowing the infantry ashore, provided it was understood that the consequence would be a delay of about six hours in the construction of the landing-piers.

The first steamer carrying the engineers arrived in Libau on the 23rd, the second on the 26th. No explanation of the long time taken for a short voyage of 600 miles is given; but it gave opportunity for the companies to make themselves thoroughly acquainted with the ships' unloading machinery.

The original orders to the engineer battalion were to construct one heavy landing pier. It was now suggested that, in addition, small landing piers on floats for infantry should be made. A trial one, 132 feet long with 40 inches depth of water at the head, was made and tested in bad weather in the outer harbour of Libau, and as it answered expectations the material for ten such piers was prepared and loaded, divided between the two ships. Rowing, too, was practised in the harbour. At the last moment, however, it was decided that the infantry should be taken ashore by the crews of the ships, and that the boats should be towed by steam launches, not rowed. On the other hand, the engineer commander was asked to construct a second landing-pier and another set of small infantry piers; but as one of his three companies would still be required to work the ships' derricks, he declined and suggested that the work should be done by the three engineer companies of the 42nd Division which was to be embarked. "The unfavourable shore conditions and lack of time for preparation militated against the success of this enterprise," as will be seen.

On the 25th September the Landing Company arrived by train from Braila without any gear; but 26 horse boats, 26 "surf boats" and the reserve bridging park, which were received by train from Antwerp, were handed over to it. Four days later, in half a gale, a landing exercise was carried out in the outer harbour "to general satisfaction." As a result of the experience gained, the Braila Company was detailed for the landing of horses and vehicles and allotted 19 steam launches. During the five days 30th September to 4th October stormy weather prevailed, but training was carried out inside the harbour, and the horse and "surf boats," as well as 22 open Hamburg barges were loaded. As the 42nd Division wished to have all its troops, horses and vehicles landed at the latest in four days and this entailed several shifts, the Braila Company asked for assistance, and the 1st Landwehr Engineer Company was allotted to it.

On the 9th October the troops and horses were put on board the transports; the men had already been drilled in embarking and disembarking by the gangways. An advance party, the sappers detailed for the landing of the infantry, the management of the open barges and the building of the piers and the reconnaissance party, with 80 infantry and some cyclists, were embarked on two torpedo boats.

The flotilla set forth at 10.30 a.m. on the 11th October and arrived off Tagga Bay, the landing place, in the grey of dawn. There was no resistance. The reconnaissance party with escort landed in collapsible boats and dinghies towed by a motor launch; but the place it struck was unsuitable for the general landing and the engineer officers ran along the beach until they found a better site. In the absence of a small boat they tested the shore for the heavy pier by wading and swimming to make certain that the pontoons when loaded would not ground on boulders or sandbanks.

The first landing of the engineers and infantry was carried out in boats towed by steam pinnaces without the use of landing-stages; but by 9.30 a.m. sufficient floats had been brought to shore to enable the building of the light piers for infantry to be begun, and very soon six piers between 60 and 120 feet long, were available, which greatly speeded up the landing. In the course of the afternoon the whole of the infantry of the division was put ashore.

By 11 a.m. the timber for the pier had been landed and its construction commenced. The sea bottom proved so stony that 150 feet out, pile-driving had to be abandoned, as the piles split under the driver; so the head of the pier was formed on barges and "surf boats." By 3 a.m. on the 13th the pier was so far finished that at 150 feet there was a depth of water of 4 feet 8 inches.

The buoys and cables for pulling the horse boats ashore had also been sent landwards in charge of two sections of the Braila Company, and by 10.10 a.m. one set was ready; but owing to anchors not holding, and the positions of the buoys having to be changed, the second set was not ready until 12.30 p.m., and the third not until 2.30 p.m. By 6 p.m., however, 393 horses and 73 vehicles had been disembarked. Work was continued all night by the light of the ships' searchlights, and although about midday on the 13th a wind got up, and the weather became stormy and squally, by evening a total of 1,128 horses and 204 vehicles were ashore. By this time, the men of the Landwehr Company attached to the Braila Company were "mostly sea-sick and nearly all quite useless." A second pier had been built by the engineers of the 42nd Division, but, owing to the wind, the water-level at its head fell to 20 inches and it had to be abandoned; the first pier suffered in the same way, the depth of water decreasing to 44 inches, and in this case it was lengthened to 280 feet, with 6 feet 6 inches at the head, sufficient for the minesweepers to bring the barges to it.

On the 16th October, after a hundred hours' work, the Braila Company, with three anchored cables and 24 horse boats, had put ashore 3,319 horses and 909 vehicles, with the corresponding personnel, about 70 per cent. of the whole.

The Braila Company was then put on two steamers and sent to Arensburg, on the south side of the island, which had already been occupied, there to land the lorries, a heavy howitzer battery and the rest of the stores at a permanent wooden pier. The two companies of the 9th Depot Engineer Battalion had on the previous evening (10.30 p.m. on the 15th) been ordered to Arensburg by road (25 miles) to repair the pier, which had been set on fire by the Russians. The first did not arrive, the roads being very bad, until 2 p.m. on the 17th, and the second, which had been delayed to pack up stores, until 3 p.m. on the 18th. By the evening of the 19th, however, the pier had been repaired, plenty of wood being available, and when the steamers arrived next morning, unloading was at once begun.

The commander of the expedition was not satisfied with having only one pier, as he might have to re-embark his troops in a hurry. Owing to the shelving shore, some difficulty arose in finding a site. One was selected, about 13 miles to the west of Arensburg by road. On the night of the 21st-22nd one of the companies of the 9th Depot Engineer Battalion, with one barge and the necessary timber, etc., was put on a steamer. On arrival at the site, as no boats were available, a section of the company was landed by means of the barge; the timber was thrown into the water and dragged ashore, the sappers wading up to their chests in the water. The other two sections of the company were landed in the same way. A detailed reconnaissance revealed that, to obtain a depth of 5 feet at the head, the pier would have to cross three sandbanks. It was decided to use piles, three piles to each pier, piers about 16 feet 6 inches apart, and by 3 p.m. on the 23rd a pier 780 feet long had been completed. Except for road building, this ended the activities of the landing companies on Oesel. On the 29th October the 9th Depot Engineer Battalion was sent back to Hamburg, and soon after the Braila Company left for Libau and Antwerp.

The writer of the article in the *Engineers Book of Honour* complains that the work of the companies received no mention in the *Heeresbericht*, or, as we should say, the *Gazette*. He might have added, nor did the General Staff give the engineers sufficient notice of the work required of them.

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## *A SUGGESTED MOBILE QUARRYING COMPANY FOR THE ROYAL ENGINEERS.*

*By* MAJOR R. D. FORRESTER, F.I.Q., R.E. (T.)

MODERN roads are an essential part of modern warfare, therefore the quarrying of road stone must be on the same basis. Whereas, during the 1914-18 War, the military road maker was chiefly concerned with maintaining the lines of communication between base positions and the front line or trench positions, in modern warfare the whole fighting unit is almost universally transported by motor vehicle.

Under these conditions the chief requirements of road stone can be grouped under three main categories:—

(*i*) Making military roads.
(*ii*) Maintaining existing roads.
(*iii*) Repairing air raid damage.

A further use of Mobile Quarrying Companies R.E. is the loading of sand (or similar substance) for filling sand bags or the supply of sand for concrete work.

It has been indicated by the progress of this war that mobility is essential to all branches of the services, and to be of any practical value, quarrying activities must be placed on the same footing.

The general principle suggested is that there should be quarrying units allocated to each area of the ground covered by the war activities. This being arranged by those in authority to meet the exigencies of the circumstances.

In certain parts of certain countries the site chosen to obtain stone for road making is not difficult to find—as for example the Highlands of Scotland. On the other hand, in certain localities such as the Fen District of Lincoln, suitable sites for road stone production are probably harder to find.

Therefore, if the suggestion of mobile quarrying units was put into practice, it should be the first duty of the Officer in Charge of the Quarrying Company to reconnoitre the area to which his Company is allocated and report to Headquarters (preferably by marked maps) probable sites for quarry operations. Then in the event of road repairs being urgently needed within the area in question, a mobile quarrying unit could be sent to the nearest suitable supply of road stone.

If this practice was adopted the road stone lorries would be concentrated near their work and would not hinder other military transport over greater lengths of road than was essential.

When manœuvring in a country which may have narrow roads, "road space" must be an essential factor. (Road space may be taken to represent the amount of road length occupied by a vehicle.) Further, when military units have to be parked in woods and other places of concealment from enemy aircraft, the less the size of the vehicle the greater number can be secluded in a given area.

Considering a Quarrying Company as a supplier of material, its road space factor must be proportionately greater than that of many other Army units because its duty is to add to the existing War supplies by procuring them out of the ground, and therefore, during a portion of its service, the vehicles belonging to it must be empty.

To minimise this, it is suggested that the vehicles of a Quarrying unit should, so far as possible, be of the trailer type. Outlined in this article are suggestions concerning these vehicles.

The personnel required for a Quarrying Company should be made up and drawn from the quarrying industry, including competent motor drivers and mechanics. In addition, there should be Officers and N.C.O's with military experience, together with the necessary "Camp followers" to attend to cooking, sanitation, etc., so that the working efficiency and mobility of the unit would not be impaired.

The following is a suggested establishment for a Mobile Quarrying Company:—

*Company Commander.*

Preferably a man with quarrying experience as well as military service. In addition to the duties required from any Company Commander, he should be competent in geological surveying to the extent of finding suitable outcrops of stone for road-making and reporting on them to his Senior Officer. He must also have a fair knowledge of plant erection and maintenance.

*Junior Officers.*

Should be competent quarry managers in Civil life, with knowledge of plant and motor vehicle repair work. They should take the earliest opportunity to become efficient in military matters.

*Non-Commissioned Officers.*

Should be preferably foremen in their particular trades and with previous military experience wherever possible. In view of the fact that many British quarrymen come from such places as Wales and Northern Scotland, foremen from these districts are advisable to look after the men, as they can speak to them in their own languages and dialects.

*Sappers.*

Care should be taken when recruiting these men that those with experience in varying types of stone are included in each unit. For example, a slate or freestone quarryman has exactly the opposite views on blasting to those of a road stone quarryman. About 75 quarrymen are sufficient for each Company, in view of the fact that supervision may have to be given to more than one quarry by those in charge of a Company. Ancillary workers to the quarrymen bring the total Company strength to about 125. Excluding the drivers (20) this means about 7 "passengers" per 30 cwt. truck, which, even allowing for their equipment, is not unreasonable when the Company is in transit.

In this article the question of living accommodation for the Company is left to the Military Authorities concerned, attention only being given to their welfare during working hours. The output from each quarry can only be based on local circumstances, but it is assumed that the Company is to have 20 petrol-driven vehicles. These would all be capable of taking a trailer and should, it is suggested, consist of the following :—

*Mechanical vehicles, with their trailers, approximate horsepower, uses and complements of men and equipment.*

*Commanding Officer's Car and Trailer.*

8 H.P. The Company Commander and his batman-driver must have complete freedom of movement, so as to be able to carry out site inspection and probably visit more than one quarry in his area. The trailer being of the light (under 2 cwt.) class and capable of containing all this Officer's and servant's equipment.

*Officer's Car and Trailer.*

20 H.P. This car is to be used for the general transportation of the Officers. The trailer to be of the caravan type which can be used under certain circumstances as an Officers' Mess, and to transport when necessary all the Officers' equipment. One batman-mess-orderly-driver to be in charge of the vehicle.

*Company-Headquarters Car and Trailer.*

20 H.P. Between the car and its trailer the entire Company Orderly Room and Staff can be transported to wherever needed. Company Serjeant-Major and two orderly room clerks (one a driver) to be allocated space in this vehicle.

*Ambulance Car and First Aid Trailer.*

20 H.P. Probably on Active Service the quarries will be situated in out-of-the-way places. An ambulance would be available for such operations in Civil work, and therefore reasonable for an Army unit. The small light trailer should be fitted up as a First-Aid Station, so that minor injuries can be attended to on the spot. Further, if more than one quarry is being worked by the same Company, the trailer can be left at one and the ambulance at another. As illustrated, the trailer to be long enough to take two stretcher cases if necessary.

A great number of quarrymen are certified First-Aid workers and no call on the R.A.M.C. need be made for routine working conditions. 1 Driver and Attendant.

*Tractor and Portable Stone Breaking Plant.*

25 H.P. As the smallest complete crushing and sizing plant weighs with wheel-mountings between 4 and 9 tons, it would be advisable to have it hauled by a tractor. The tractor can be used, when not in transit, to drive the plant.

Depending on the amount of "sized" stone required, one or more of these units should be allocated to each Company. Additional stone crushing is referred to later. 1 Tractor Driver.

*Lorries.*

The remaining 14 vehicles allotted to the Company are of the 30 cwt. lorry body type with removable canvas hood and preferably simple tipping bodies. All these vehicles should be fitted to take trailers.

For general transport purposes all the Company's working stores and personnel can be carried in these fourteen lorries. The trailers for attachment to these lorries with their corresponding reference numbers shown on the diagrams would be as follows :—

| *Trailer No.* | *Use.* | *Design.* |
|---|---|---|
| 6A | Air Compressor | Standard |
| 7A | ,, ,, | ,, |
| 8A | Rations | ,, |
| 9A | Field Kitchen | ,, |
| 10A | Canteen | ,, |
| 11A | Petrol | Illustrated |
| 12A | Explosives | ,, |
| 13A | Machine Shop | Standard |
| 14A | Crusher | Illustrated |
| 15A | ,, | ,, |
| 16A | Power Unit | ,, |
| 17A | ,, | ,, |
| 18A | Water | ,, |
| 19A | Wheelbarrows | Standard |
| 20A | Loader | ,, |

Without giving full particulars of these trailers, the following details supplement the diagrams.

*Field Kitchen.*

It would be necessary to give the men one or more meals away from their living quarters. A kitchen stove with usual culinary requirements could be housed in a caravan-type trailer for this purpose.

The canteen would be on the same lines.

*Petrol Store and Explosives.*

Both these products should be carried in containers which can be placed in isolated positions away from the main operations. When operating in a "danger area," the detonators can be stored or carried in a separate vehicle away from the main explosives, special portable receptacles as used for similar stores can be provided. A trailer affords sufficient cover and at the same time releases a petrol-driven vehicle for transport of road stone.

*Stone Crusher and Driving Engine.*

A trailer design is shown enabling these two items to be transported on separate trailers, but joined by distance pieces when working to make up a four-wheeled vehicle.

*Water Carrier.*

Water for drinking and machine-cooling purposes may be difficult to find at the quarry site and a tank trailer would be useful.

*Loading Shovel and Elevator.*

As these items can be mobile, one of each are included in the equipment. Their uses would be for the removal of overburden or stone, and the rapid loading of lorries. These two units are of standard manufacture, only requiring rubber tyre mounting.

# A SUGGESTED MOBILE QUARRYING COMPANY FOR THE ROYAL ENGINEERS.

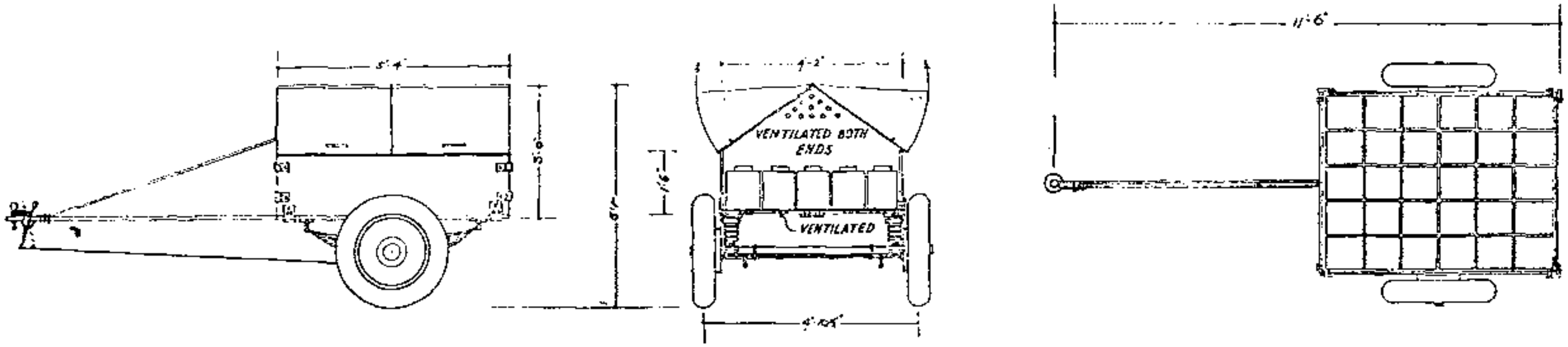
SHEET NO. 1.

| VEHICLE UNIT NO. | VEHICLE | H.P. | TRAILER | TRAILER UNIT NO. | OVERALL ROAD SPACE | SERVICE | RANK & NO. CONVEYED |
|---|---|---|---|---|---|---|---|
| 1. | SMALL SALOON | 8 | SMALL BOX. | 1A | 19'-0". | O/C & EQUIPMENT | OFFICER 1 BATMAN 1 |
| 2 | LARGE SALOON | 20 | CARAVAN | 2A | 31'-0". | OFFICERS & EQUIPMENT. | OFFICERS 3 BATMAN 1. |
| 3. | LARGE SALOON | 20 | CARAVAN. | 3A. | 31'-0". | ORDERLY ROOM | C.S.M. 1 CLERKS 1 |
| 4. | CONVERTED SALOON | 20 | SMALL CARAVAN (2 STRETCHERS) | 4A. | 29'6". | AMBULANCE. | SAPPERS 2 |
| 5 | TRACTOR | 20. | CRUSHING PLANT. (10 TON PER HOUR) | 5A. | 25'0". | CRUSHING. | SAPPER 1 |
| 6 | 30 CWTS TRUCK | 25 | AIR COMPRESSOR | 6A | 28'-0". | COMPRESSED AIR | SAPPERS 8 |
| 7 | . . . . | 25 | . . . . . | 7A | 28'-0". | . . . . . | . . . . |
| 8. | . . . | 25 | RATIONS. | 8A | 25'6". | RATIONS | . . . |
| 9 | . . . | 25 | FIELD KITCHEN. | 9A | 29'6". | FOOD. | . . . |
| 10 | . . | 25 | CANTEEN (DRY) | 10A. | 29'6". | CANTEEN (DRY). | . . . |
| 11 | . . . | 25 | PETROL STORE | 11A | 30'6". | PETROL | . . . |
| 12 | . . . | 25 | EXPLOSIVE STORE. | 12A | 25'-6". | EXPLOSIVES | . . . |
| 13. | . . | 25 | MACHINE SHOP | 13A | 31'6". | REPAIRS & SMITH. | . . . |
| 14 | . . | 25 | CRUSHER | 14A | 27'6". | CRUSHING. | . . . |
| 15 | . . . | 25 | . . . | 15A | 27'6". | . . . | . . . |
| 16 | . . . | 25 | PETROL ENGINE | 16A | 28'6". | POWER UNIT | . . . |
| 17. | . . | 25. | . . . . | 17A | 25'6". | . . . . . | . . . |
| 18 | . | 25 | WATER TANKS | 18A | 26'0". | WATER | . . . |
| 19 | . . . | 25 | WHEEL BARROWS | 19A | 31'6". | WHEEL BARROWS | . . . |
| 20. | LOADING SHOVEL | 35 | ELEVATOR | 20A | 50'-0". | ELEVATING | SAPPER 1 |
| TOTAL | | [illegible] | | | 580'-0". | | 133 |

# A SUGGESTED MOBILE QUARRYING COMPANY FOR THE ROYAL ENGINEERS.

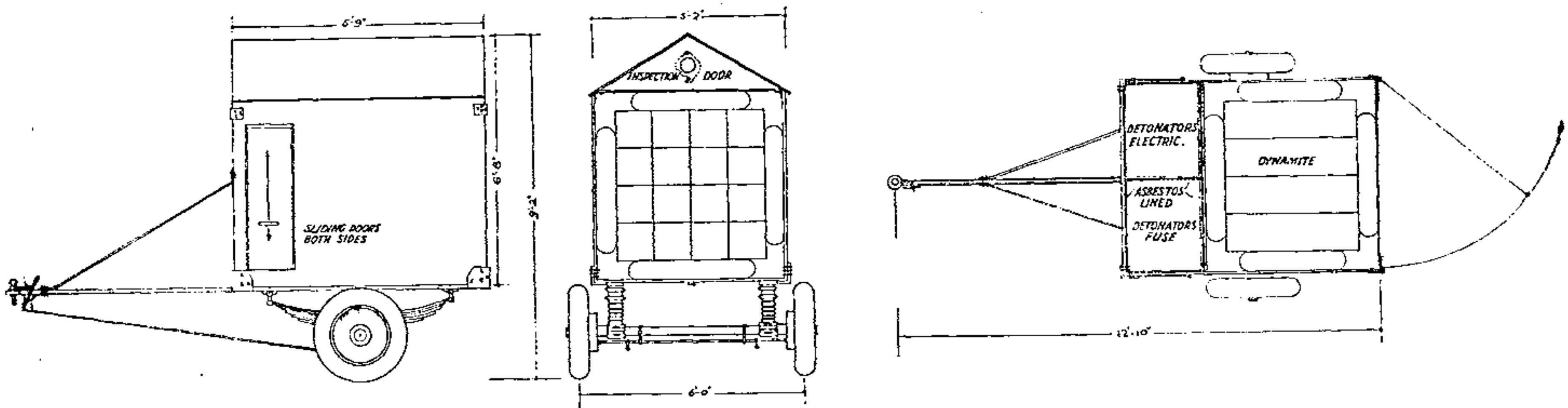
SHEET NO. 2.

DETAILS OF UNITS 11A, 12A & 18A



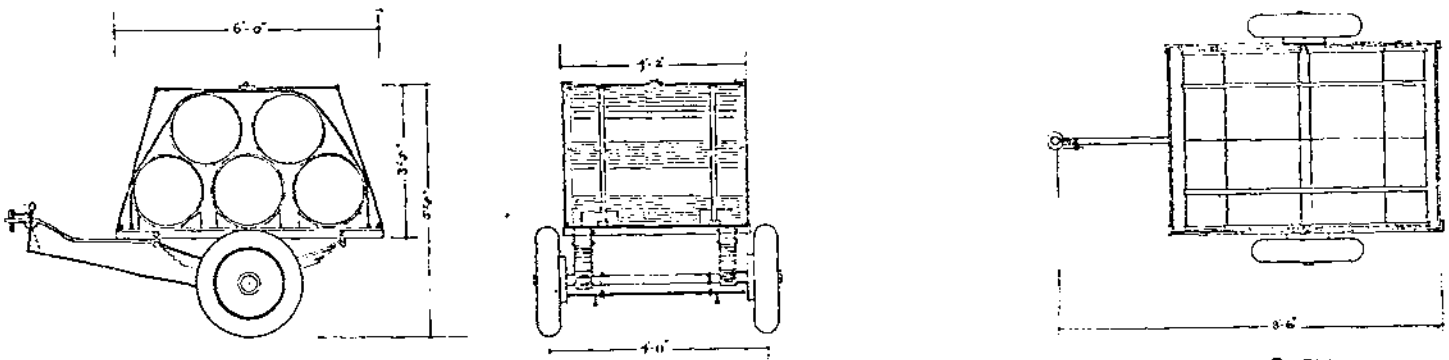

SIDE ELEVATION. SECTION PLAN.

PETROL STORE.




SIDE ELEVATION. SECTION. PLAN

EXPLOSIVE STORE.



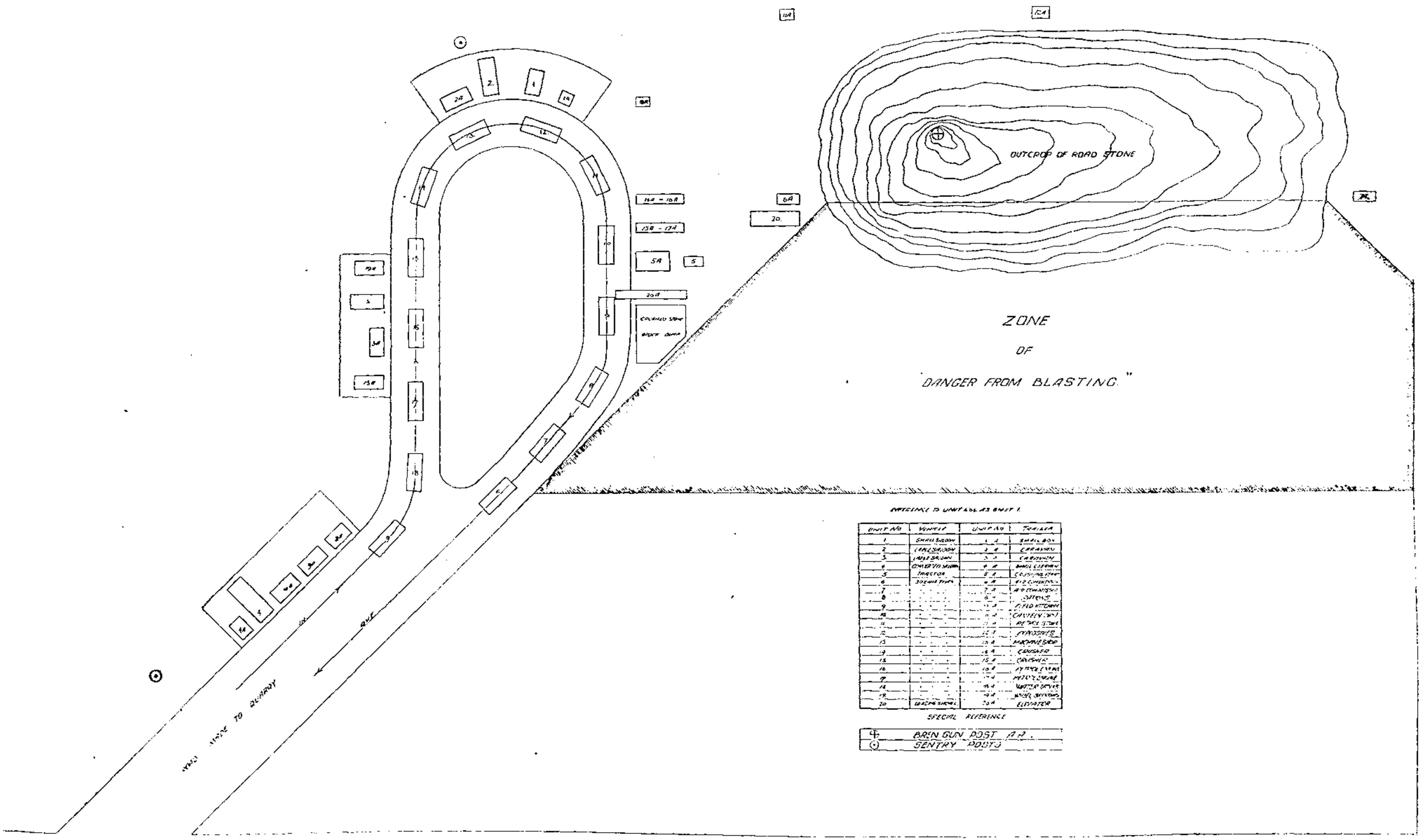

SIDE ELEVATION. SECTION. PLAN.

WATER TANKS

# A SUGGESTED MOBILE QUARRYING COMPANY FOR THE ROYAL ENGINEERS.

SHEET NO. 3.

LAYOUT PLAN




REFERENCE TO UNIT [illegible] AS SHEET 1.

| UNIT No | VEHICLE | UNIT No | TRAILER |
|---|---|---|---|
| 1 | SMALL SALOON | 1 A | SMALL BOX |
| 2 | LARGE SALOON | 2 A | CARAVAN |
| 3 | LARGE SALOON | 3 A | CARAVAN |
| 4 | CONVERTED SALOON | 4 A | SMALL CARAVAN |
| 5 | TRACTOR | 5 A | CRUSHING PLANT |
| 6 | 30 CWT TRUCK | 6 A | AIR COMPRESSOR |
| 7 | - - - | 7 A | AIR COMPRESSOR |
| 8 | - - - | 8 A | OFFICES |
| 9 | - - - | 9 A | FIELD KITCHEN |
| 10 | - - - | 10 A | CANTEEN [illegible] |
| 11 | - - - | 11 A | PETROL STORE |
| 12 | - - - | 12 A | EXPLOSIVES |
| 13 | - - - | 13 A | MACHINE SHOP |
| 14 | - - - | 14 A | CRUSHER |
| 15 | - - - | 15 A | CRUSHER |
| 16 | - - - | 16 A | [illegible] |
| 17 | - - - | 17 A | PETROL ENGINE |
| 18 | - - - | 18 A | WATER [illegible] |
| 19 | - - - | 19 A | [illegible] |
| 20 | MECH. SHOVEL | 20 A | ELEVATOR |

SPECIAL REFERENCE

| | |
|---|---|
| ⊕ | BREN GUN POST A.A. |
| ⊙ | SENTRY POSTS |

It should be noted that the explosive, Petrol and Water trailers are designed to resist damage by Small Arms Ammunition and Incendiary Bomb attack—this being effected by sloping steel roofs and multiple component containers respectively.

*Supplies.*

As already indicated, the unit is designed to work during the day away from its base—or living quarters. It will not be necessary to hold a large supply of stores at the quarry. It is not possible to form any estimate of the amount of petrol required for the lorries, as this is entirely dependent upon the volume of output and the distance from the point of supply to the road construction operations. However, the supply of petrol carried by the unit, when in operation, is intended to be sufficient to meet the running requirements of the power units employed in the quarry. Also the Water trailer should make the unit, when operating, independent of outside supply both for machine-cooling purposes and the men's personal needs.

*Dimensions.*

The entire unit is designed to come within the height and width of standard road vehicles. The longest single vehicle is the elevator (marked 20A in diagrams) —but being of light construction would be easily handled. Probably one of shorter length could be used if this proved a difficulty. As indicated on the diagram, the Total Road Space of the whole unit would be approximately 200 yards of column, and 450 square yards of " Parking area."

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## *GROUND DEFENCE OF AERODROMES.*

*By* MAJOR R. E. SMYSER, *Jr.*

(Reprinted from *Infantry Journal* (Washington) for December, 1941.)

RECENT events of the war, particularly the successful air-borne invasion of Crete, have focused attention upon the ground defence of airfields. Judging from some of the general comment, correct strategy would demand the employment of the entire army to protect the air force ground installations. But this neglects the obvious fact that an army on the defensive, tied to selected pieces of terrain, cannot win a war. Moreover, airfields are but one among the many kinds of installations in rear areas that must be given adequate protection from new methods of attack.

Attacks on vital points in the rear of an army are as old as war. Now it is parachute and air-borne infantry that enable an attacker to hurdle all obstacles and strike against such points with heavy force. We may indeed use the vertical envelopment against any good target, but the concept has become associated primarily with attacks on aerodromes. Admittedly, the defence against air-borne troops is new and not conclusively tested in war, but the problem is realistic, and it can be solved by the correct application of proven methods, used with imagination.

The most general form of attack used against aerodromes is bombardment from the air. The enemy may use any of a number of different means for such an attack—demolition bombs weighing from 100 to 4,000 pounds, incendiary bombs, bombs filled with chemicals (both demolition and chemical bombs may be either of the impact or air-burst type), chemical spray, and the fire of machine guns or larger weapons carried by attacking planes. The fire of aeroplane weapons is not strictly a form of bombardment, but we may consider it here since it is usually a part of any low-flying attack, and defensive measures that are adequate against bombs protect also against automatic small arms and aircraft cannon fire.

The attack upon an aerodrome may come from any altitude and from any direction. There is usually some warning, but a degree of surprise is always probable. The aim, of course, is to destroy aircraft and installations or neutralize the aerodrome by damaging the runways and servicing facilities. Though chemicals have not been employed in the present war, we must nevertheless consider the possibility of an attack using high explosives, incendiaries, and persistent chemicals.

As the term is used here, a ground attack means a direct attack upon an aerodrome by ground units, either foot or mechanized. If the attack comes as part of a general hostile advance, then the defence of the airfield loses its special character and becomes merely the defence of a terrain feature by usual methods. The air units will almost certainly have evacuated the aerodrome, which will consequently not have the special value as an objective it would otherwise have.

A probable form of ground attack on an occupied aerodrome is that of a mechanized raiding force. Such attacks may come with little warning and will be pushed home with great rapidity, using a large volume of automatic small-arms fire and some light cannon fire. Hence cover and protection will be needed for effective defence.

Vertical envelopment as used in this discussion means an attack by troops using ground arms, and weapons after landing by parachute planes, or gliders. Surprise may be achieved by such an attack even against an alert enemy. The attacker, who can concentrate his whole force upon the focal point, retains the initiative. No more than a few seconds may elapse from the time the first planes come over until the first parachutists are on the ground preparing to seize critical points. There is no time for the defence to estimate the situation and then plan appropriate measures. There must be an adequate plan already prepared for automatic execution, in which changes can only be made as the situation develops.

An intensive bombardment of the aerodrome and especially of its defensive weapon emplacements, usually precedes such an attack. This may come from either high or low altitude but will be almost sure to include dive bombing and machine gunning of anti-aircraft weapons. The parachutists then land in force on and near the aerodrome from low altitudes with automatic weapons, explosives, small calibre A.T. cannon, and small mortars. They will immediately attempt to gain critical points in accordance with assigned tasks. Some may attempt to remove obstacles or clear a nearby area for transports to land upon. Next come reinforcements from transport planes and perhaps gliders which land wherever possible in the vicinity. These units are more heavily armed and will have light field guns, trench mortars, and even light tanks.

What are the defensive measures we must take against these forms of attack? We can in fact, either cultivate a thick hide or grow sharp teeth. Using passive measures, we build structures and installations that give us protection but may not discourage the enemy. Active defence, of course, involves fire and movement. Let us consider both these types of defences.

You can build massive structures, impervious to bombs and artillery fire, to give shelter to planes and areodrome personnel, but to do so is to make of an aerodrome a fortress, which runs beyond the realm of the practicable. For any type of plane, the cost of an underground or other bomb-resistant shelter is roughly two to four times the cost of the plane. It is obvious that it is better to build planes themselves than such shelters.

It is entirely practicable, however, to proportion the protection to the value of each element of the aerodrome in the defence scheme. Thus, at an exposed aerodrome, some protection is desirable for control and operational buildings, repair facilities, personnel, fuel and explosives, aircraft on the ground, utility installations, and certain defence structures. If installations are spread over a large area, the probability of a particular element being destroyed is reduced. This is especially true of repair facilities and aircraft on the ground.

Mass destruction of aircraft on the ground has been successful only when the planes were stored in large hangars or lined up in the open. Planes can be dispersed over a sizable area around the aerodrome, and if need be, earth revetments can be constructed around each of them to limit the risk of damage to direct hits.

As for repair facilities, only the actual machine tools and spare parts are vital. A simple, steel-frame, corrugated-iron hangar gives all the cover needed for an aeroplane under repair. Such a structure is fire resistant, and even a direct hit from a large bomb will not destroy the whole structure, although it may blow a large hole in the floor, or tear off part of the roof and siding. Within such a hangar, simple concrete blast walls will give nearly complete protection to installed machines, and spare parts can be kept either in separate buildings or given special protection. Naturally, personnel would not stay in such a building during a raid, so the main damage would be the loss of a few planes.

Defensive installations for fighting men and weapons should be of standard field fortification type, supplemented by concrete pillboxes when time and material permit.

Dispersion is another passive method of aerodrome defence. Through its use any particular target becomes less attractive and remunerative. Nevertheless, dispersion is not a cure-all and has certain disadvantages.

First, the more land used, the greater the cost. In addition, the actual cost of all installations rises because of the increased length to be covered by roads and utilities. Dispersion may therefore actually double the cost. It also makes operational control somewhat more difficult, but adequate training supplemented by improved communications should offset this. A final objection to dispersion comes from the fact that a proper defence for the installations of a widely scattered airfield requires a much larger force than for a more compact one. It is unquestionably desirable to keep the defensive forces at the minimum, but in view of the protection obtained through dispersion, this added cost will often be worth while.

Perhaps the best solution is selective dispersion rather than general, both off and on the aerodrome. In the first place, all elements of an aerodrome do not have to be at the field. For example, the barracks. Provision for a part of the command on twentyfour-hour duty is needed but most of it can be housed in groups somewhere close to the flying field. Such small separated cantonments can actually be part of the aerodrome reservation, but there is no great argument against having them a mile or more away, provided there are good roads or streets to the field. Similarly, messing, recreational facilities, post exchanges, and even certain supply facilities could be placed convenient to the housing areas, but somewhat away from repair hangars, and other conspicuous land marks. All technical installations can be on or close to the aerodrome site, but dispersion in self-contained groups will increase their protection at slight cost.

Dispersion of the planes themselves is also vital. When they are spread around the perimeter of the aerodrome, and in adjacent areas, only minor losses are possible, especially if revetments, as mentioned earlier in this article, are used. This gives the greatest security with the minimum cost.

Camouflage is also an important element among passive measures of protection. Few things have been so badly misunderstood and misused—and often neglected entirely—as the different practicable methods of screening, confusing, and misleading an enemy through camouflage. Camouflage can only be fully effective if it is considered in the original planning, and not applied as an afterthought. Without going into its technique, it does one or more of three things—diminish, deceive, or disguise. To these we can add the use of dummies.

"Diminishing" an object is simply to make it less conspicuous—more like its natural surroundings without changing its apparent size, shape, or position. The second step, "deceiving," implies a change or apparent change in size, shape, or position. The logical continuation of deception is disguise, through which you attempt to make your object appear to be some other thing, and naturally one that is not a suitable target. The final element of camouflage is the erection of dummies, a method of use only in combination with some of the other elements. A dummy airfield, complete with dummy planes, may be worth while if the actual location to be protected can be kept in doubt. The dummy installation must not only simulate the actual one; it must not be too conspicuous, and it must be reasonably near the locality to be protected.

It is not necessary that the decoy be of an entire airfield. Thus the defence may benefit by false weapon emplacements, strong points, and aircraft revetments. Any method that leads the enemy to waste his fire is worth while. Certain actual installations, such as A.A. weapons, can stay silent during the first of the attack, thus adding to the deception.

One point in connection with camouflage of air installations should be emphasized. It is nice to be able to fool the camera, but not essential. Bombing is not precision firing from map co-ordinates, and unless the bombardier can readily discern his objective, accurate bombing is impossible. Camouflage is highly successful if it forces the enemy to stay for a long time over the target while trying to identify it, for this permits defensive aircraft and weapons to operate effectively. At the same time, little advantage accrues from trying to fool the enemy about the location of an installation accurately spotted by the junction of two rivers or any other readily distinguishable natural landmark. But this merely emphasizes the fact that camouflage is a beforethought, not an afterthought.

Now let us consider the uses of obstacles. For the defence of aerodromes, they have three general purposes: to prevent the landing of aircraft, impede the advance of mechanized vehicles, and hinder the attack of foot elements.

The first thought here is of methods of making the landing areas unusable. But this is only a sound thought if you no longer desire to use the aerodrome yourself, which you will usually want to keep on doing. But you will want to deny its use to the enemy during his attack. No satisfactory method has yet been devised for this. At first glance, a system of cables on the surface of the ground but readily hoisted to ten feet or so seems feasible. But when the size of an aerodrome is considered, the cables and machinery required to raise them makes this impracticable. Similarly, large portable steel tetrahedrons, or poles placed in the ground, will wreck a descending aeroplane but take a lot of time to put in place, and these can also be destroyed or removed by parachutists. About the only rapid, temporary method of blocking a runway is to use motor transport, preferably vehicles that can be towed, but are not easily moved by man-power alone. Old motor vehicles or construction machinery will serve. But as we know, the time between the first warning of impending attack and the actual landing of parachutists may be too short for such means to be used.

A general use of obstacles that is more practicable lies in blocking all roads and level areas in the areas around an aerodrome on which the enemy might otherwise try to land his gliders or planes, even with considerable risk of damage in the landing. For this, any large objects, such as concrete pipes, junked automobiles, old farm or construction machinery, concrete blocks, steel tetrahedrons, are good. The obstacles must be so spaced that a plane in landing must strike at least two of them in a hundred yards of run.

One objection to such obstacles is that they prevent full utilization of the ground. Fixed cables or upright poles will avoid this, but cables and poles must be securely anchored and strong enough to cause a definite accident to any plane or glider striking them. It also seems that suspended contact mines would greatly increase their effectiveness.

For causing damage to landing planes the best obstacle of all is probably a ditch or trench. Trenches about three feet wide and six feet long are highly effective, and cannot be easily filled in by parachute troops. The dirt from the trenches should be placed along the edges. Craters can be similarly used.

To prevent mechanized advance, the same obstacles are used as in ground warfare, such as steel rails embedded in concrete, concrete blocks, dragons teeth, log barricades, ditches, or any similar obstruction. Normally these are of use only on routes of approach and must be covered by fire.

In considering the advance of troops we must remember that parachutists may land on or off the aerodrome and, hence, attack may come either from within or without. Within the aerodrome proper all key establishments should therefore have complete wire protection, either with industrial-type, man-proof fencing or barbed wire. Such enclosed areas are centres of resistance and must be garrisoned for defence.

On the perimeter of the aerodrome, the problem is primarily to prevent entrance. Owing to the size of an aerodrome, all-round wire protection may not be practicable in the theatre of operations. It is, however, desirable for all permanent aerodromes to have such protection, not only against attack but against sabotage.

Up to the present, demolitions and mines have been little used in Europe in the protection of aerodromes. They can, of course, be used against landing aircraft and advancing tanks and troops. The obvious way to use them is to blow craters in the runways and usable landing areas. This could be done in advance of an attack, as upon abandoning an airfield, or through the use of charges to be exploded just as the enemy lands. This second method, though desirable, is probably too uncertain for general use. An attacking enemy will almost always bomb parts of the aerodrome, which is apt to sever the wires leading to the charges, or even detonate charges and mine fields themselves. It has been suggested that mine chambers should be built under runways of permanent fields to permit easy demolition, but this appears unnecessary.

Against mechanized vehicles, demolitions can create an effective obstacle, especially where defile routes of approach through unpassable terrain can be destroyed. In the defence of an aerodrome, provision snould be made for instant destruction of such places. Contact mine fields can also be used effectively to protect certain types of approaches.

So far this discussion has concerned only the passive means. But a passive defence, no matter how completely organized it is, can in time be overcome by an aggressive enemy who has retained the initiative. In only one way can an aerodrome be adequately defended—by attacking the attacker in stronger force—by an active defence.

Without question, against air action, the effective defence from a broad viewpoint is counter air action. However, there is no place in this article for a discussion of air tactics, and we will limit our discussion to the ground means.

Of these means, the first essential is the warning service established by higher authority in which every aerodrome will normally be included. The local warning system should consist of a general alarm signal, such as a siren or special horn, to alert the command and send it to its battle stations. Specific signals are also needed. If the enemy is simply going to bomb the aerodrome, the bulk of its personnel can be in air raid shelters. But to resist vertical envelopment, or a mechanized attack, the maximum defence effort must be made with all personnel. Special signals are also needed to indicate a gas attack and these should be given by special gas sentinels.

To supplement these warnings, there must also be some methods of giving selected information or orders. For orders to aircraft on the ground at dispersed locations and to anti-aircraft or defence reserves, a loud speaker system is suitable.

For dealing with hostile planes at high altitudes, heavy anti-aircraft artillery must be available at every aerodrome, although the amount will depend on the size and location of the installation. Such guns can also be given secondary missions against tanks. There must be not one but several alternate positions for each gun, and everything possible must be done to deceive the enemy as to the exact location occupied. Where time permits, dummy weapons should be set up in every location, and if possible, mechanisms for producing flashes and dust clouds installed. Sandbag traverses should be also built around the guns and the whole then camouflaged.

Naturally, anti-aircraft guns will be located outside the aerodrome. Hence it will not usually be possible to include A.A. emplacements in any organized defensive zone. Each gun will be responsible for its own local security, although the arms available for this may well be augmented.

The automatic and semi-automatic cannon, and calibre .50 machine guns used against low-flying aircraft and dive bombers must be located nearer the aerodrome, but need an all-round field of fire. If necessary, some of them can be placed on nearby hills, or roofs of buildings on or off the aerodrome, or even on special platforms erected along the edges of nearby woods. Alternate emplacements are desirable but are not as important as for the larger guns.

For their secondary uses against ground targets, some of these lighter weapons must be able to cover the landing area and any roads or adjacent fields on which the enemy might land planes or gliders. Troop-carrying enemy aircraft attempting to land must be brought under heavy enough fire to destroy the aircraft as well as the troops.

These weapons should, of course, be included in the aerodrome defence zone. This does not mean that there must be a continuous defensive line held around the airfield, but rather that these weapons should be worked into a series of defence strong points capable of vertical as well as all-around horizontal fire.

Experience in Europe has indicated that modern aircraft cannot be seriously damaged by a few calibre .30 hits. Hence, weapons of this size are better reserved for use against the enemy's troops.

Recently a number of new weapons have been tried in the defence of aerodromes in Europe. These are mainly rocket guns of different types in multiple batteries, designed to be effective at low altitudes. Some of these have powerful explosive charges set to explode at a predetermined altitude. Others trail wires or metal streamers to entangle aircraft, and may have a parachute attachment with small bombs. The plane strikes the streamer and this draws the bomb against the plane. These devices all appear to be still experimental.

Searchlights must be included as A.A. elements. Too much reliance cannot be placed on the ability of searchlights to illuminate fast-flying bombers even at medium altitude, but they are needed for close defence. Their location must be changed frequently.

As far as practicable, all weapons capable of both uses should be employed against both ground and air targets. Field artillery, anti-tank guns, and machine guns, of course, have primary ground defence missions.

The actual assignment of a unit of field artillery to the local defence of an aerodrome would probably be exceptional. But where, for example, there are aerodromes on an island which may be subject to air-borne attack, or isolated airfields in the theatre of operations exposed to hostile mechanized attack, artillery may well be necessary. When thus used it should by all means retain its full mobility. To emplace the guns would make them liable to discovery and destruction by the enemy before they can be of any use. Until an attack develops, they should be kept concealed, ready for instant employment.

Against an air-borne attack, field artillery will find its greatest use in covering landing areas near the aerodrome on which the enemy may attempt to land his transport planes. The destruction of the first aircraft that attempts to land may well result in the failure of the enemy operation at that point. Even if the enemy does succeed in landing, accurate fire can destroy his infantry as they assemble to form for the attack. Field artillery should also be effective against any small tanks that may be landed early by the enemy.

Anti-tank weapons must, however, be the main reliance for defence of an aerodrome against mechanized attack, and are also of great value against landed hostile aircraft and automatic weapons, and against planes in the air. But there must, of course, be enough A.A. and A.T. weapons, either separate or dual-purpose, to carry out both of these vital tasks.

Machine guns are the backbone of organized defence against parachutists and air-borne infantry. The perimeter of the field, as well as the landing area, must be covered by fire from mutually supporting positions, and there should be some posts within the building area to cover vital installations. Nearby areas suitable for the landing of parachutists should also be covered by the fire of automatic weapons, though dispersion must not be too wide, for the enemy will have the initiative and will be able to concentrate initially superior forces at the point he selects to attack. A balance must be struck between a mere line defence of the perimeter and a wide defensive zone surrounding the aerodrome.

A large amount of fire power in a short time at any threatened point can be gained either by having many guns everywhere, or by having a few very mobile armoured weapons, which is the more feasible solution.

In foreign armies a few armoured vehicles, often improvised, have been assigned to the defences of aerodromes. But where air-borne attacks have been made against aerodromes so defended, the preliminary bombardment has destroyed these units before their effectiveness could be tested. Nevertheless, it seems evident that armoured vehicles, kept under cover away from natural bombing targets, can be invaluable, if not decisive. For it will seldom be possible to cover all dropping or landing areas near an aerodrome by fixed or semi-emplaced weapons. An air-borne attack still in its first stages can be readily broken up.

It has long been accepted as axiomatic that every unit is responsible for its own security. But mechanized vehicles and aeroplanes require some adjustment of this view. To some extent, there can be warning of the approach of mechanized vehicles in time for preparatory measures to be taken so that A.T. weapons will be able at least to delay the attack. Aircraft, however, are not bound by existing routes of communication or hindered to any extent by natural obstacles. But the troops of air units normally at an aerodrome to service and operate aeroplanes are insufficient in numbers, deficient in armament, and cannot even be located properly to resist effectively an attack by air-borne troops. Consequently special defence units are needed, either as an organic part of the air forces or from the ground arms.

It has already been pointed out that an aerodrome is only one of many installations in rear areas that may be subject to sudden attack. The defence of all these places, including the aerodromes, is therefore a matter for the field army commander, who should allocate to each aerodrome any defence forces required. Obviously, this must be the minimum strength consistent with the value of the installation and the time necessary to get reinforcements to it if it is attacked.

It will be necessary to have certain defensive posts and all A.A. weapons manned at all times. The same applies to a lesser extent to selected anti-tank weapons on likely routes of approach, and machine-gun posts in vital areas. Other posts can be left partially manned or even unoccupied, but with definite garrisons assigned to them. No reliance should be placed for such defence duties upon men who have some other full-time job at another part of the aerodrome. Air corps personnel engaged in operating or servicing aircraft should assist in the defence of the aerodrome by creating small islands of resistance near their normal places of work. Such a series of garrisoned points forms a defensive zone that will limit the movement of enemy troops. Where the larger numbers of troops are available, as near hangars and shops, air corps as well as service personnel should have designated assembly points for their employment as a mobile force or as a reserve.

It is never certain that the enemy will attempt to drop parachutists, or land on the aerodrome itself. Some troops may thus be used to make a diversion, but it is probable that the bulk of the initial wave will be somewhere off the aerodrome but not far from it. These landings must be dealt with quickly and ruthlessly, for it is at this instant that the decision is gained. Armoured vehicles should be supported by infantry, in trucks. Even without armoured vehicles, trained troops should rapidly gain the upper hand, even over a parachute force of considerably larger size, if their own action is rapid and determined. For the defending units will not only have the advantage of knowing the terrain, but their individual weapons will be superior both in volume and range over those of the air attackers.

The defence commander must have a spotting system for accurately identifying the dropping points, and an efficient method of dispatching units to any of these points. This element of the defence pre-supposes that the defenders in sufficient numbers have survived the preliminary bombardment, and this can only be accomplished by keeping these troops under cover in concealed locations near the aerodrome, but not in the aerodrome building area or generally around the perimeter.

No matter how thorough the defence preparations, it is probable that a determined enemy will be able to make a landing at one or more points and resist the small mobile forces sent against him. To overrun these centres of resistance immediately, the local defence commander needs a reserve. Part of this reserve should be from his special defence force, but it is here that good use can be made of the additional personnel of the air corps, and allied arms and services who have collected at designated assembly points. It is plain that all personnel will require training in the use of the rifle and in simple infantry tactics. Aviation engineer units are already so trained.

It is not intended to say that any aerodrome can unsupported resist an aggressive enemy. But if the local defence can prevent the enemy for a few hours from seizing the field and bringing in large air-borne reinforcements, it will have done its job. Regional reserves or reinforcements must be able to get there in not over three hours.

The local defence of an aerodrome should be the responsibility of the air officer commanding the installation, with all arms and services, including anti-aircraft and special defence forces, under his control. The defence plan can, however, be prepared and executed by a special assistant, a "defence officer." The defence officer could command all defence units at the station, air corps included, for the actual defence operations. During an attack this officer would be solely responsible for the employment of all defence personnel, subject only to the need of the air units for personnel for air operations.

There is one further element of active defence that deserves consideration, the repair of damage from enemy action including that of chemicals and incendiaries. Manifestly, during an attack, and particularly one in which explosives, incendiaries, and chemicals are employed, it will be impossible to wait until the attack is driven off before the work of repair is begun. Fires must be dealt with promptly, communication systems maintained and decontamination carried out, as well as repairs to buildings, runways, or utility services.

Co-ordination of all repair work is required. Hence, to help the defence officer, a damage control officer should be appointed to direct these activities. Personnel for this work will normally come from service troops augmented by specially trained air corps personnel. During an attack itself, only the minimum repair details would be exempted from the general defensive combat duties. As soon as the attack has been beaten off, the work of repair would proceed at a full pace.

In conclusion, we may say that every campaign in Europe so far has shown beyond all question the necessity for thorough measures of aerodrome defence.

Such defences cannot be haphazardly planned for, any more than any other type of defence. In any defence effort, it is complete planning, organization, and training for the special problems involved that insures the success of the defensive mission.

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## *A CORPS FIELD PARK COMPANY, ROYAL ENGINEERS.*

*With particular reference to the Ideal Layout of Field Stores and Workshops.*

By MAJOR C. C. PARKMAN, M.INST.C.E., R.E.

THE Establishment of a Corps Field Park Company, R.E. and its equipment allows a very technical unit of the Royal Engineers to carry out highly skilled work in the Field. At the same time this basic organization can, by good planning and initiative, be easily further developed when static conditions prevail to enable it to become a worthy augmentation to the Work Service organization, with first-class purchasing, workshop and stores departments, in addition to maintaining its role as a unit of a Field Formation.

It is with reference to this static condition, when greater opportunity occurs to develop the full resources of the establishment of the Company, that it is proposed to devote these notes as it is considered that having once established the ideal in static warfare conditions, the attainment of the ideal in mobile conditions will be made so much easier. Even under static conditions, however, sight must not be lost of the unit's mobile role and the unit must be prepared and exercised to load quickly all equipment, to move and establish new workshops and stores dumps and to improvise, wherever possible, but the ideal established under static conditions should always be made the guiding pattern.

As will be seen the establishment allows 3 sections and a Headquarters Section, each section being entirely different with varying transport and separate tradesmen and equipment, so that each may carry out its own special role in war. The transport for the whole unit is described under a special heading.

### FIELD STORES SECTION.

(a) *Personnel.*

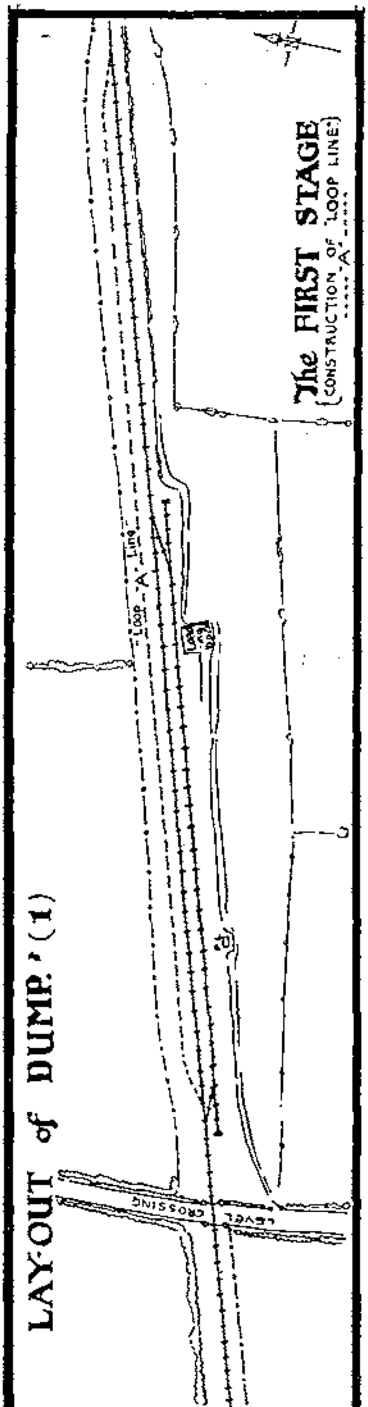
The number of men shown in the establishment bears no relation to the Section's importance as, under either mobile or static conditions, it has been found that at least 50 additional O.R's are needed to run the Section efficiently.

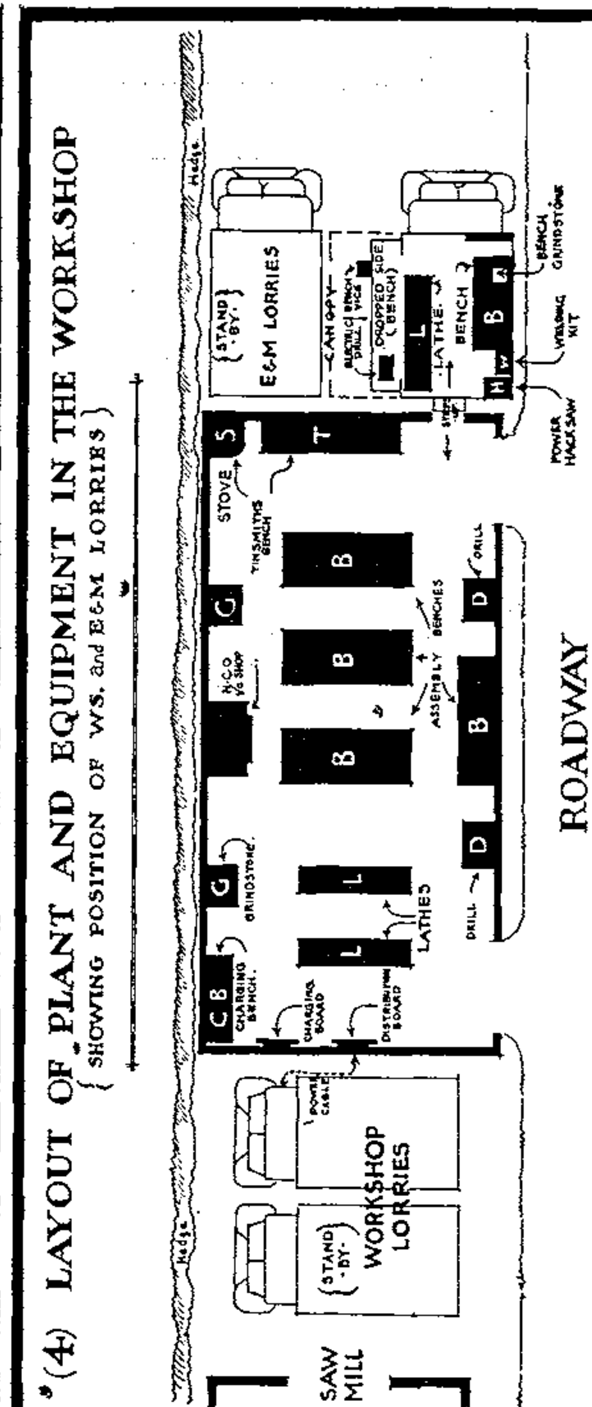
No officer is allocated to this section but experience has shown that the Subaltern shown in Headquarters Section should be attached to the Field Stores, where the work is of a very responsible nature. For the same reason experience has shown that it is essential that one Staff Serjeant (E.E.S.) from the E. & M. Section be transferred to the Field Stores Section. It is not however the purpose of this paper to criticize the War Establishment but rather to suggest the most economical and efficient manner of making use of it, based on actual experience both of mobile and static warfare, to the best advantage of the unit as a whole.

(b) *Siting of Field Stores.*

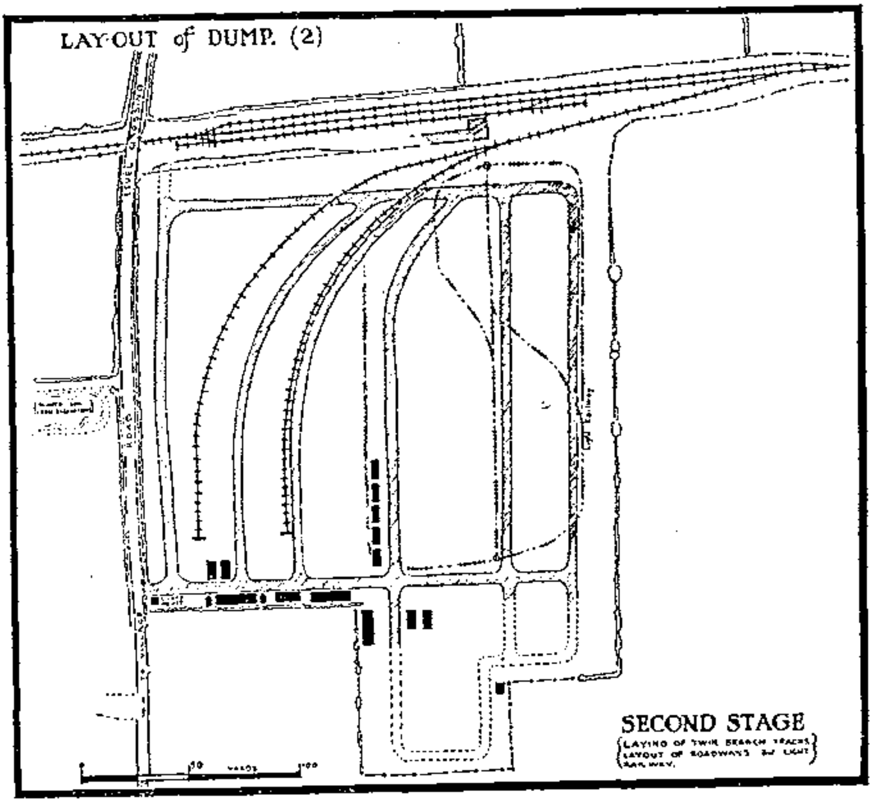
The first and most important task to be undertaken is that of siting the Field Stores, whether under mobile or static conditions, and, subject to other considerations of policy, the ideal layout for the Field Stores calls for adequate road and rail facilities to reduce the double handling and consequent loss of time to a minimum.

Drawings 1, 2 and 3 are attached showing the stages of development of what is considered the ideal layout of Field Stores of a field unit. Drawing No. 1 gives


LAYOUT of DUMP '(1)
The FIRST STAGE
(CONSTRUCTION OF 'LOOP LINE' 'A')
LOOP 'A' LINE
LEVEL CROSSING


(4) LAYOUT OF PLANT AND EQUIPMENT IN THE WORKSHOP
(SHOWING POSITION OF WS. and E&M LORRIES)
Hedge.
(STAND-BY-)
E&M LORRIES
CANOPY
ELECTRIC BENCH DRILL
BENCH VICE
DROPPED SIDE (BENCH)
LATHE.
BENCH
BENCH GRINDSTONE
WELDING KIT
POWER HACKSAW
STEPS
STOVE
TINSMITHS BENCH
H.Q. CO. YS SHOP
BENCHES
ASSEMBLY
DRILL
GRINDSTONE
LATHES
CHARGING BENCH.
CHARGING BOARD
DISTRIBUTION BOARD
POWER CABLE
WORKSHOP LORRIES
(STAND-BY-)
WORKSHOP LORRIES
SAW MILL
ROADWAY

the first stage showing the minimum railway sidings necessary to work a turnover of between 20-50 wagons daily. In this stage double handling cannot be avoided in transferring the stores to the Stores Field. Drawing No. 2 gives the second stage of development when the railway sidings are provided in the Stores Field and considerably cuts down the double handling and economises on the unit transport necessary for moving stores. It will be noted that adequate road facilities are available, worked on the one way system and it has been found that a road adjoining the siding is a tremendous advantage for reconsignment by road




transport. Where storing takes place the stores are directly offloaded and stacked immediately adjacent to the siding and for this purpose no road is necessary.

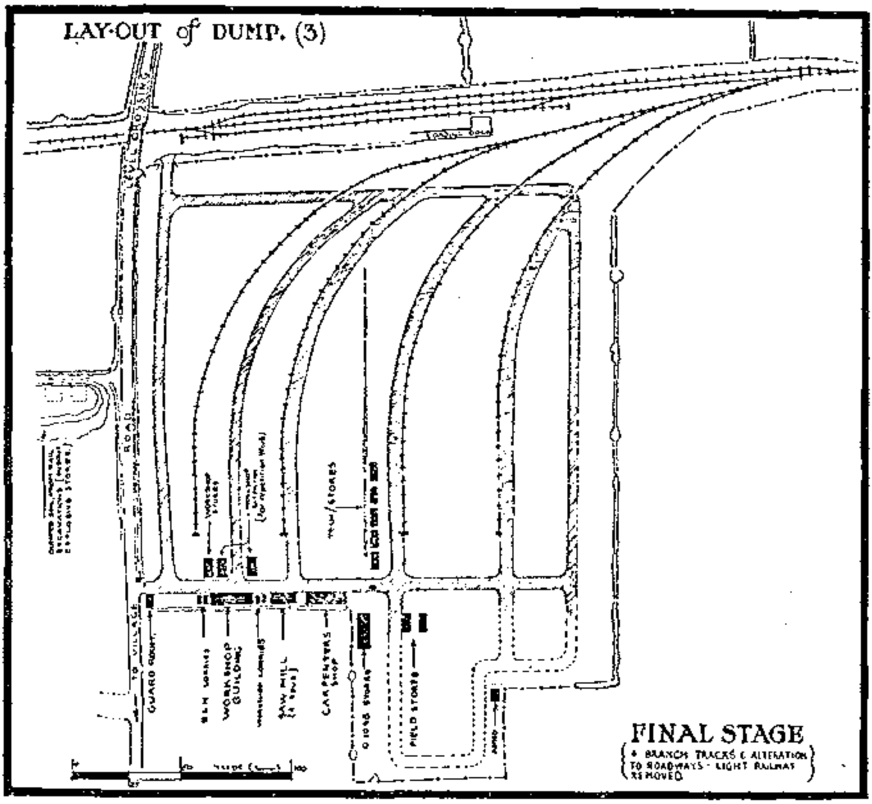
Drawing No. 3 shows the final stage giving excellent siding and road accommodation. Any extension of this stores area would, as far as is practicable, be carried out by extension of the sidings, giving an oblong shape to the stores area and maintaining direct offloading facilities to speed up either consignments by road or by rail.

Where no locomotive is available for the unit's use for shunting wagons into certain positions it is found that the co-operation of the Railway Company is essential to arrange a morning and evening delivery and collection of wagons. Thus the first delivery and collection takes place at 10.00 hours and the second at 16.00 hours—advantage is taken of the Railway Company's engine and any shunting necessary is carried out.

This system further ensures an adequate steady supply of railway wagons, better distribution of stores and the additional facilities of being able to move wagons to any particular stack of materials.

In siting these field stores consideration must also be given to water supply available for fire fighting services, electric power for lighting and possible supply for Workshops and, in view of the amount of stacking in the open that must necessarily be carried out by this type of unit, so the nature of the ground should be preferably sandy and well drained.

Sites that have some natural camouflage are an advantage but it is considered that, with the rail and road facilities described, camouflage, unless undertaken




on a very large scale, can only be considered in broad outline such as a general attempt to extend the boundaries of the adjacent village or a possible blending into the existing surroundings.

(*c*) *Duties.*

(i) *Purchasing.*—One of the most important duties of the Stores Section, whether under mobile or static conditions, is its organization for the purchasing of R.E. stores. Under mobile conditions, and particularly is this so when operating with an expeditionary force, before the normal supplies of Engineer Stores become available, the Section is responsible for locating supplies, estimating demands, formulating contracts, supplying and purchasing R.E. stores to Divisional and Corps Troops. To this must often be added the difficulty of transacting all business in a foreign language and the keeping of a stores imprest account in the currency of the country. Under static and semi-static conditions the amount of purchase is reduced because the normal organization is either in working order or else rapidly becoming so and it is the type or quality of the store which alters.

Under these conditions the Section has to locate special technical stores, since the standard of work under static conditions is on a higher level and special contracts outside the normal stores supply have still to be arranged. In addition, the Section is the accounting department for all stores passing to the Divisions and Corps and has to certify, pass for payment and keep a local purchase system for the Corps Formation. The stores officer and at least one staff serjeant must devote a considerable amount of time to this branch of the work.

(ii) *Accounting of Stores.*—The present trend to value all stores received and issued by the Corps Field Park Coy., R.E. in terms of £. s. d. has a lot to commend it, as these values reach astounding figures and this has the tendency of impressing upon personnel of the section the absolute importance of correct accounting. Elementary though this may seem if accurate records are to be kept and the figures of stocks held are to be of any value, correct checking of all issues and receipts by the outside staff is imperative. The office staff in turn, apart from performing all the routine duties such as the completion of forms for the despatch by road and rail, can save the outside staff a considerable amount of hard work by endeavouring to effect the reconsignment of stores wherever possible.

It has been found essential to form a separate Field Stores office and to train at least two Pioneers R.E. for work in this office, in addition to the Field Stores Corporal who has been placed in charge, the outside work being in charge of the Serjeant and both the inside and outside work being supervised by the Officer.

All accounting in the Field Stores Section, relative to stores, should be done on a daily basis. This ensures that stock lists are up-to-date and accurate, while information as to the quantity of any stores held can be given at any particular time. Either of the following methods may be used for this purpose:

(*a*) Stock books for materials and stores, showing entries of receipts and issues daily,

(*b*) Card index system, showing daily issues and receipts and stocks in hand.

The former method is more cumbersome and mistakes in entry of items are more prone to occur, as a considerable number of items are enumerated on one sheet of the ledger. In the case of a card index system, which is considered preferable, a separate card, A.F. K. 2418, is used for each item.

It must be stressed, however, that although a most efficient book-keeping system may be in force in the Field Stores Office, the accuracy of the stock sheets, ledgers or cards depends entirely upon the storemen who check the stores and materials in and out from the dump. They must not only be conversant with all types of stores and materials but they must render accurate returns daily to the Field Stores Office.

(iii) *Receipt, Distribution and Consignment of Stores.*—The Stores Section must keep a record of all stores received, supervise allocation and arrange consignments of stores both by road and rail transport. In this connection before siting stacks of materials consideration must be given to the type of stores, its demand (whether likely to remain in the stores dump any length of time), its bulk (having regard to any crane facilities which might exist), and deterioration (determining amount of shelter or maintenance necessary), the ultimate destination (whether by road or rail), before actual sites are allocated in relation to either roads or railways.

Tables are appended showing areas necessary for bulk storage of various materials and the stores dump must be surveyed so that the capacity for any given stores can be accurately determined before acceptance of any consignment. The tables also show composite stores in capacities of 30-cwt. or 3-ton lorries and railway trucks, so that a quick reference can be made by stores personnel in either indenting for transport or in advising units for collection so that full economy of transport may be effected at all times.

The stores personnel must have available at all times a ready reference so that full advice can be given for any such questions of stores capacity, area required, transport necessary—mechanical means of handling if necessary, weight and bulk of various stores; this has the effect of increasing, in the stores personnel, an intensive, intelligent interest in this most important subject of R.E. stores supply.

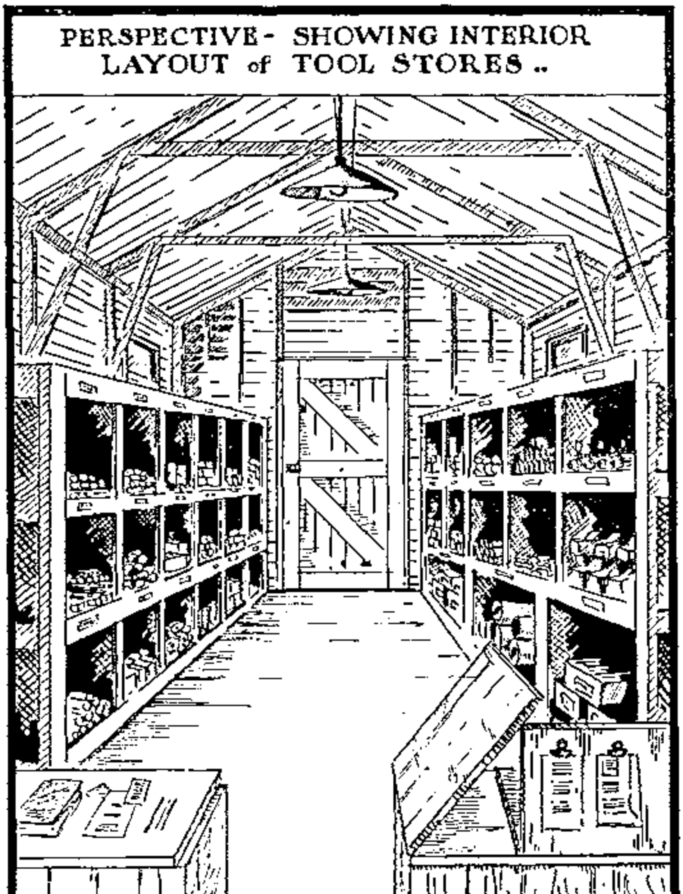
Records for checking in and out of all stores—the correct completion of railway forms to ensure proper allocation of railway charges—the correct detailing of stores for consignment by rail so that rail charges may be cut to a minimum—proper handling, loading and storage of different classes of materials, form a most important part of the work of the Field Stores Section.

(iv) *Maintenance of Stores and Technical Equipment.*—The Field Stores Section must be responsible for the adequate maintenance of the stores and technical equipment. With this end in view it is recommended that a Staff Serjeant from the E. & M. Section be permanently attached for the purpose of checking technically all stores and equipment received, ensuring that all damage and deficiencies are immediately repaired and made good and that continuous maintenance is carried out. This responsibility cannot be too highly stressed and Field Companies should confidently expect that stores despatched from the unit are up to standard in dimension and quality to fulfil the task for which they are allotted and all technical equipment is complete and in first class working condition. It is not sufficient merely to accept stores, stack and despatch, consideration must always be given to this most important aspect of the Engineering side of the Field Stores work.

A Corps Field Park Coy. should intelligently anticipate Field Companies' requirements in stores and equipment, should keep in touch with works in progress, be ready at all times to make suggestions for improvement and if necessary be prepared to submit alternative designs for works so that full use may be made of materials and equipment in the dump when standard materials are not available.

Certain of the stores must, of necessity, be stored in the open and in point of fact many do not require to be kept under cover but regard must always be given to adequate ventilation by supporting on dunnage, good spacing to facilitate maintenance and handling, painting and greasing to keep them in serviceable condition. A considerable quantity of stores and technical equipment should, however, be preferably stored under cover. Here again adequate room should be allowed for maintenance and in the case of certain equipment periodical operation should be carried out. Sketches of stores sheds are given showing suggested divisions of equipment under cover, with layout of major items with their accessories—lighting and pumping sets, etc., come under this category. The equipment held for Field Companies is kept separately under cover and an accurate plan should be maintained of exact positions of all stores and equipment in the field and a detailed statement of all items of equipment held under cover should be kept in the office and a copy posted on the door of the hut in question. This method prevents a lot of confusion and saves time in handling if emergency calls are made for stores after dark.

(v) *Fire Precautions.*—The unit as a whole is responsible for fire fighting, but the large quantity of inflammable and expensive stores and equip-




ment which soon accumulate, particularly under static conditions, make it another duty for Field Stores personnel to organize positions of reserve water supply in the areas of first priority.

The most important part of fire fighting is of course " Fire Prevention " when reference to *Regulations for Army Fire Services*, 1934 and *Notes for Guidance on Army Fire Services* should be made.

The various fire notices required under A.C.I. 265/1933 should also be exhibited and " No Smoking " notices in M.T. Workshops, petrol stores, carpenters' shops and particularly in the stores field. The Company now carries several No. 4 Pumping Sets and they should be available for use in fighting fire, together with a supply of half filled sandbags for dealing with incendiary bombs. The timber stored in the dump is usually the biggest fire risk and therefore this should be dispersed as much as possible with wide gangways between the stacks and with non-inflammable material stacks at intervals amongst it as a fire screen. If possible, metal water tanks should be dispersed amongst

PERSPECTIVE - SHOWING INTERIOR LAYOUT of TECHNICAL STORES ..

the timber so that the stirrup pumps and pumping sets can be brought quickly into use.

(vi) *Security*.—When even an approximate estimate of the value of stores and equipment held on the smallest dump is made it will be found to reach a surprisingly high figure. The scarcity of stores in war-time tends to place a greater value on them and for this reason adequate security measures must be taken not only to prevent pilfering but also to ensure the accuracy of the Field Stores accounting for these stores and equipment. Unit security personnel must be well trained to watch for any suspicious occurrence in the vicinity of the Field Stores area and in the absence of adequate infantry guard the whole dump should be surrounded by a suitable fence, such as a 6-ft. barbed wire fence to prevent easy access from outside, with only one entrance, where the unit guard-room is situated and a sentry permanently mounted. His duty is to check the identity of all those entering the dump and see that lorry loads on leaving approximate with the A.B.108. All enquiries for stores should be made at the Field Stores Office, where identity and authorization to draw are checked and A.B.108 completed, against which the serjeant in charge of the dump will issue on presentation.

## Workshop Section.

(*a*) *Layout of Workshops.*

The Workshops should, for preference, be sited on the stores dump, as shown on the attached layout, Drawing No. 3, to facilitate access to stores and materials. All stores are obtained through Field Stores Section on signature and are properly accounted for and charged against the Workshops Order Number. This system enables accurate costs to be maintained against each job carried out in the Workshops and provides an essential estimating record for the pricing of any work to be undertaken.

(*b*) *Equipment.*

The equipment used in the workshops is that contained in the two 3-ton, 6-wheeled, Machinery R.E. 24 K.W. lorries (commonly referred to as Workshop Lorries) on the establishment.

All the plant is removed and installed for preference in a brick-built workshop with a concrete floor. A detailed layout of the workshop is given, on Drawing No. 4 (See page 26) from which it will be seen that, except for two circular saws which are housed separately, a quite efficient workshop can be laid out. Power is taken from the Workshop Lorries, which stand adjacent to the workshop, to a distribution board in the workshop. Normally each lorry supplies power at 110 volts D.C. to its own equipment but it has been found practicable to run both sets of machinery, less one circular saw, from one lorry with the added advantage of always having the second workshop lorry as a standby for maintenance and emergency purposes.

This workshop can very easily be increased in efficiency by a small expenditure on additional machinery, as will be seen in the layout of the workshops. Special jobs may be such that it will be necessary to purchase a small power-driven wood-turning lathe and a morticing machine, which will considerably increase the efficiency and it is further suggested that with the addition of other machines, *e.g.* 2 Universal milling machines, these workshops could easily be organized to produce articles such as jigs and tools which would further ensure a 100% efficient use of the very valuable plant already existing in these Workshop Lorries. An improvised charging panel may be installed as shown, the resistance being obtained in part from the workshop lighting, and will be found very useful and in continuous use for charging M.T. batteries.

As will be seen, the two circular saws are housed in a separate saw mill. This is very desirable and enables the workshops personnel to work better free from noise and also enables the workshops to be kept very much cleaner. Any supplementary machinery purchased should be driven by 110 volt motors, so that they can form a permanent part of the lorry equipment and take their power from same. It is an advantage to split the workshops lighting between the lorries at 110 D.C. and the 230 A.C. normal electric supply and enables the workshop to carry out work in the event of a breakdown of either.

Under static conditions the two E. & M. lorries are parked adjacent to the Workshop and used to supplement the productive capacity, but the plant is not removed from these lorries, which are maintained ready to proceed on any outside job at short notice.

A separate workshop for carpenters and joiners, consisting of a wooden living hut, 54′ × 16′, exists and Nissen huts, erected to suit requirements and useful for repetition bench work, various mass produced work, painting and storage, are shown on the plan.

(*c*) *Organization.*

The plan shows suitable layout.

Thorough maintenance and cleaning of all plant and equipment is essential and the shops are swept out daily and two hours per week are devoted to clearing up. Tools are issued and returned from a tool store established in a separate hut, where they are arranged in racks in such a way as to be readily accessible for issue, maintenance and checking. All tools must be signed for at the time of issue and periodical tool checks are essential.

Strict supervision of the workshops must be exercised and no work should be carried out without a works ticket (specimen attached). This is prepared in duplicate, signed by the O.C. unit, and one copy is passed to the N.C.O. i/c Workshops, the other being retained in the office for record. Material is charged against the Works Ticket Number and an accurate cost maintained for future reference.

A works detail sheet is prepared each evening for the following day showing the task allotted to each man and nominates the N.C.O.s. in charge of jobs. The N.C.O. in charge of the Workshop prepares a daily statement showing the time devoted by each man to the appropriate tasks, and these form the basis of a Daily Works Progress Report and a Weekly Works Summary, the latter giving the number of man-hours devoted to each category of work during the week.

A high proportion of the work carried out has necessitated the adoption of mass-production methods, the work being divided into a number of operations on each of which one or more men are employed. With these methods very careful checking, both of the component parts and of the finished article is essential and storage arrangements also must be designed to avoid damage and deterioration of the articles manufactured and to facilitate stock-taking and checking of consignments.

When operating under static conditions it has been found preferable to form a pool of the Workshop and E. & M. Sections so as to employ equipment and labour to the best advantage, and the E. & M. Officer controls the work of both Sections. By this central control maximum efficiency is attained, as any repetition work by the E. & M. Section on outside work is immediately transferred to the workshops by the E. & M. Officer. Further, the War Establishment does not authorize an officer for the Workshop Section and the control of these two sections by the E. & M. Officer has been found to be preferable to having the workshop section under the control of either the Field Stores Officer or the Second-in-Command.

(*d*) *Supply of Power to Workshops.*

Although the normal power supply under mobile conditions must of necessity be that generated by the Workshop lorries at 110 volts D.C. and all the equipment in the lorries is designed for this supply, it is debatable whether under static conditions this is the best policy. The installation of a motor generator giving the required output at 110 volts D.C. and taking its supply from the existing electric supply mains, would cut out wear and tear of these Workshop Lorries, which are so essential to mobile warfare and would in addition conserve petrol. Even on the Continent consideration might well be given to this aspect of operating W.D. designed machinery at 110 volts D.C. Continental supply of electrical energy, although at 120 volts A.C., is certainly well conceived and appeared to be well distributed even to the most remote villages in Northern

France and, wherever static conditions prevail and allow, it is suggested that full use should be made of these existing supplies.

### E. & M. Section.

Two 3-ton, 6-wheeled Machinery (E. & M.) lorries comprise the technical equipment of the Section.

The plant is to be used, as far as possible, to supplement the Workshops but should not be removed from the lorry and for convenience' sake it has been found desirable to park these E. & M. lorries adjacent to the workshops as shown in the layout. Part of the duties of this section is the taking over of electrical and mechanical plant, their operation and local maintenance, the operation and repair of all machinery and plant, the extension of local electrical and water supply systems, the operation of the Corps Headquarters lighting sets and the demolition, as far as possible, of all electrical, mechanical and water supply systems in a withdrawal. In both static and mobile conditions it has been found very useful to have this technical section forward in the Corps area for carrying out the duties described.

### Transport.

The transport laid down for each section appears to vary in inverse ratio to the personnel carried by the section and it is found in practice that in a Corps Field Park Company, R.E., it is preferable to run an unofficial transport section under the second-in-command as Transport Officer.

By this means all the transport is pooled and each section indents on the M.T. office for any lorries it requires. This method shows great economy of petrol, etc., as frequently two or more trips can be made with one lorry and often with a more economical sized lorry than the particular section has on its establishment. For this reason the three 8-cwt. and two 15-cwt. trucks are in great demand and motor cycles are likewise pooled and used by tradesmen to go out on jobs with a few tools.

By this method increased efficiency in maintenance is also effected, as there are less lorries in use and more time for the drivers to look after their lorries. Drivers carry out their own maintenance on the task system and one of the unit motor mechanics is available to carry out minor repairs, adjustments, etc. Anything beyond a minor repair is performed by the L.A.D., to whom are attached the other unit motor mechanics. Thus only one repair shop is utilized and the unit repairs have the advantage of supervision by the qualified W.O.I. of the L.A.D.

Weekly M.T. inspections are carried out by the M.T. Serjeant, A.B. 406 inspections monthly by the M.T.C. and periodically by the L.A.D.

Normally, one Workshop lorry should be working whilst the other is under maintenance. The E. & M. lorries are used by Workshop Section when necessary but should always be ready for instant moving to an outside job. A driver is detailed to each lorry and always drives that particular lorry, and in the case of the Workshop and Machinery lorries, having once started the vehicle, the driver, except for periodical visits, can be put on other jobs in the vicinity. The motor cycles are in the charge of the M.T. L/Serjeant who should be responsible for their maintenance and that they are issued to tradesmen and S/Sjts. as required.

### Conclusion.

It is hoped that these notes, which have only dealt with two Sections of a Corps Field Park Company, R.E., in any great detail, have shown the possibilities of development which exist for that type of unit if full use is made of its technical equipment and establishment of skilled personnel.

## *LOADING AND STORAGE TABLES.*

| Section. | R.E. vocab. No. | Article. | Method of Storing. | Storage space per 1,000 in cu. ft. | Storage area per 1,000 in sq. ft. | Unit | Wt. lbs. | 1 man load. No. | 1 man load. weight. | Lorry loads. 15 cwt. | Lorry loads. 30 cwt. | Lorry loads. 3 ton | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | Sleepers | Stacks of 120, 12 layers of 10, 9′×9′×6′ 3″ | 4225 | 730 | No | 112 | ½ | 56 lbs. | — | 25 | 40 | |
| 1 | 10 | Pit props 9″ dia. × 10′ | Stacks of 96, 8 layers of 12 poles 10′×10′×6′ high | 6250 | 1000 | No | 180 | ½ | 90 lbs. | — | 18 | 36 | |
| | | Pit props 6″ dia. × 10′ | Stacks of 216, 12 layers of 18, 10′×10′×6′ high | 2800 | 460 | No | 90 | 1 | 90 lbs. | — | 36 | 75 | |
| 2 | 16a | Duck-boards | Stacks of 54, 18 layers of 3. 5′ 6″×5′ 6″×6′ | 3400 | 560 | No | 35 | 1 | 35 lbs. | 34 | 52 | 130 | Stacked in groups of 4, 3′ spacing between stacks. |
| 2 | 22 | 'A' frames, small | Stacks of 15, 3′×3′×5′ | 3000 | 600 | No | 30 | 1 | 30 lbs. | — | 40 | 80 | |
| 2 | 22 | 'A' frames, large | Stacks of 15, 5′ 6″×3′ 6″×5′ | 6400 | 1280 | No | 50 | 1 | 50 lbs. | — | 20 | 40 | |
| 3a | 60 | Asbestos Sheets 6′ ×3′ | Stacks of 250 to height of 5′ | 360 | 72 | No | 36 | 1 | 36 lbs. | 40 | 125 | 125 | Peg every 10 sheets |
| 3a | 65 | C.I. Sheets 6′×2′ 2″ | Stacks of 500 to height of 3′ | 72 | 24 | No | 22 | 1 | 22 lbs. | 50 | 250 | 350 | Peg every 10 sheets. Size, shape and nature of Material make these difficult to handle. |
| | | 7′×2′ 2″ | Ditto | 84 | 28 | No | 24 | 1 | 24 lbs. | 40 | 200 | 325 | Ditto |
| | | 8′×2′ 2″ | Ditto | 96 | 32 | No | 26 | 1 | 26 lbs. | — | 150 | 300 | Ditto |
| 3b | 104 | Cement, ordinary | Stacked in layers of 3 to height of 3′ | 2000 | 2000 | tons | 112 | 1 | 112 lbs. | 15 | 30 | 60 | |
| 3b | 264 | Bricks, building | Stacks of 1,000 to height of 5′ | 55 | 11 | 1000 | 6¾ | — | — | 250 | 500 | 1000 | |
| 3b | 385 | Felt, roofing | Stack on end, 2 layers height of 6′ | 3000 | 1000 | Rolls | 85 | 1 | 85 lbs. | 16 | 35 | 65 | |
| 3b | 421 | Netting wire, 36″ ×2″ mesh | Stacks of 18 rolls, 6 layers of 3, 3′×3′×6′ high | 3000 | 500 | Rolls | 55 | 1 | 55 lbs. | 15 | 40 | 80 | |
| 3b | 422 | Netting wire, 48″ ×2″ mesh | Stacks of 40 rolls, 8 layers of 5, 4′×4′×6′ high | 2400 | 400 | Rolls | 75 | 1 | 75 lbs. | 12 | 30 | 70 | |

LOADING AND STORAGE TABLES.—*continued.*

| Section. | R.E. vocab. No. | Articles. | Method of Storing. | Storage space per 1,000 in cu. ft. | Storage area per 1,000 in sq. ft. | Unit | Wt. lbs. | 1 man load No. | 1 man load weight | Lorry loads 15 cwt. | Lorry loads 30 cwt. | Lorry loads 3-ton | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3b | 703 | B.R.C. fabric 17′ ×7′ | Stacked in layers of 100 to height of 3′ | 3570 | 1190 | No | 89 | ½ | 44½ lbs. | — | — | 50 | Open lorry only |
| 3b | 814 | 3″ Stove piping 6′ lengths | Stacks of 324, 18 layers of 18, 6′×6′×6′ high | 660 | 110 | No | 35 | 1 | 35 lbs. | — | 60 | 120 | |
| | | 3″ Stove piping 3′ lengths | Stacks of 162, 18 layers of 9, 3′×3′×6′ high | 330 | 55 | No | 18 | 2 | 36 lbs. | — | 100 | 200 | |
| 4a | 900 | Piping, water | (In pens according to length) | (Dependent on length of pipes) | | | | | | | 3,500 ft.<br>1,000 ft.<br>750 ft.<br>400 ft. | 7,000 ft.<br>2,000 ft.<br>1,500 ft.<br>950 ft. | ½″ dia. piping<br>1″ dia. piping<br>2″ dia. piping<br>3″ dia. piping |
| 6n | 2174 | Stoves S.C. | (Stacked in layers of 2) 4′ high×1′ 6″ diam. | 4500 | 1000 | No | 60 | 1 | 60 lbs. | 15 | 30 | 50 | |
| 9 | 2952 | Axes, pick, complete | Helves in stacks of 250, 3′×3′×3′ high | 108 | 36 | No | 1 | 5 | 5 lbs. | 200* | 420* | 840* | *Complete |
| | | | Heads in stacks 400, 40 per layer 3′×3′×2′ 6″ | 56 | 25 | No | 4½ | 6 | 27 lbs. | | | | |
| | | | | | | | (Carried | on one | Helve) | | | | |
| 9 | 2956 | Barrows wheel | Stacked upright on wheel 3′×1′ 6″×4′ | 18000 | 12000 | No | 70 | 1 | 70 lbs. | 8 | 20 | 30 | |
| 9 | 2993 | Expanded metal 6′ 6″×3′, ¾″ mesh | Stacks of 240 bundles of 20, 6′ 6″×3′×3′ | 244 | 85 | No | 8 | 3 | 24 lbs. | 60 | 200 | 400 | |
| 9 | 3002 | Hessian canvas 36″ ×100 yds. | Stacked in layers of 2 to height of 6′ | 6750 | 1125 | Rolls | 84 | 1 | 84 lbs. | 15 | 40 | 80 | |
| | | Hessian canvas 72″ ×100 yds. | Ditto | 12000 | 2000 | Rolls | 168 | ½ | 84 lbs. | 10 | 20 | 40 | |
| 9 | 3029a | Pickets A. I. short 2′ | Stacks of 800 2′×2′×5′ high | 25 | 5 | No | 4½ | 10 | 45 lbs. | 330 | 650 | 1350 | 18″ spacing for loading and stacking. In bundles of 10 |
| 9 | 3029c | Pickets A. I. long 6′ | Stacks of 1500 6′×6′ × 5′ high | 120 | 36 | No | 13½ | 5 | 67½ lbs. | 125 | 250 | 500 | 18″ spacing for loading and stacking. In bundles of 5 |

LOADING AND STORAGE TABLES—*continued.*

| Section. | R.E. vocab. No. | Articles. | Method of Storing. | Storage space per 1,000 in cu. ft. | Storage area per 1,000 in sq. ft. | Unit. | Wt. lbs. | 1 man load. No. | 1 man load. Weight. | Lorry loads. 15 cwt. | Lorry loads. 30 cwt. | Lorry loads. 3-ton | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 3030a | Pickets, screw, short 17½" | Stacks of 400, 10 layers of 40, 1' 6" × 1' 6" × 5' high | 27 | 6 | No | 3 | 10 | 30 lbs. | 400 | 800 | 1600 | 18" spacing for loading and stacking. In bundles of 10 |
| 9 | 3030b | Pickets, screw, long 5' 7" | Stacks of 1,000, 10 layers of 100, 6' × 6' × 6' high | 216 | 36 | No | 6 | 10 | 60 lbs. | 100 | 400 | 800 | 18" spacing for loading and stacking. In bundles of 10 |
| 9 | 3032a | Pickets park 5' | Stacks of 500 in layers of 20, 5' × 5' × 6' high | 300 | 50 | No | 15 | 3 | 45 lbs. | 100 | 250 | 500 | |
| 9 | 3040 | Sandbags | Bales of 1,000, 5 layers of 4, 10' × 10' × 6' | 12½ | 6 | No | 504 | 200 (Sandbags) | 100 lbs. | 2000 | 6000 | 12000 | 4 man load per Bale of 1000 |
| 9 | 3047 | Shovels G.S. | Stacks of 120, 24 layers of 5, 2' 6" × 2' 6" × 5' high | 266 | 52 | No | 3¾ | 5 | 19 lbs. | 100 | 750 | 1500 | |
| 9 | 3049 | Shovels R.E. | Ditto | 266 | 52 | No | 5½ | 5 | 27½ lbs. | 100 | 500 | 1000 | |
| 9 | 3047a | Wire, barbed 28 lbs. coils | Stacked in coils, 500 to occupy 10' × 10' × 5' | 1000 | 200 | Coils | 28 | 1 | 28 lbs. | 40 | 100 | 200 | By using an A.I. Picket (long) 4 coils can be carried by 2 men |
| | | 56 lbs. coils | Ditto | 1000 | 200 | Coils | 56 | 1 | 56 lbs. | 20 | 50 | 100 | |
| 9 | 3077a | Wire, plain or G.I. 8 S.W.G. | Stacked in tiers, 10 coils per tier 2' 6" × 2' 6" × 5' | 3000 | 600 | Coils | 56 | 1 | 56 lbs. | 20 | 100 | 200 | 1 cwt.— 300 yds. |
| | 3077b | 10 S.W.G. | Ditto | 3000 | 600 | Coils | 56 | 1 | 56 lbs. | 20 | 100 | 200 | 1 cwt.— 750 yds. |
| | 3077c | 12 S.W.G. | Ditto | 3000 | 600 | Coils | 56 | 1 | 56 lbs. | 20 | 100 | 200 | 1 cwt.—1180 yds. |
| | 3077d | 14 S.W.G. | Ditto | 3000 | 600 | Coils | 56 | 1 | 56 lbs. | 20 | 100 | 200 | 1 cwt.—2200 yds. |
| | 3078 | Wire binding 18 S.W.G. | Ditto | 3000 | 600 | Coils | 56 | 1 | 56 lbs. | 20 | 100 | 200 | 1 cwt.—3950 yds. |
| | N.I.V. | Wire, Dannert | Stacked in tiers, 15 coils per tier 4' × 4' × 6' high | 6400 | 1068 | No | 49½ | 1 | 49½ lbs. | 10 | 35 | 60 | Open 3-ton lorry will take 80 |
| | N.I.V. | Hurdles, brushwood 6' × 3' | Stacks of 20 to height of 4' | 3600 | 900 | No | 34 | 1 | 34 lbs. | 15 | 40 | 60 | Bulk limiting factor |
| | N.I.V. | Ditto 12' × 3' | Ditto | 7200 | 1800 | No | 72 | ½ | 36 lbs. | — | 20 | 30 | |

LOADING AND STORAGE TABLES—*continued.*

| Section. | R.E. vocab. No. | Articles. | Method of Storing. | Storage space per 1,000 in cu. ft. | Storage area per 1,000 in sq. ft. | Unit. | Wt. lbs. | 1 man load No. | 1 man load weight | Lorry loads. 15 cwt. | Lorry loads. 30 cwt. | Lorry loads. 3-ton | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N.I.V. | Pickets forestry 2′ 6″, 2″-3″ diam. | Stacks of 200, 20 layers of 10, size 2′ 6″×2′ 6″×6′ high | 190 | 32 | No. | 5 | 10 | 50 lbs. | 350 | 700 | 1400 | Groups of 25 stacks, 4′ spaced between groups for fire precautions. |
| | N.I.V. | Ditto 6′, 3″ to 4″ diam. | Stacks of 400, 20 layers of 20, size 6′×6′×6′ | 650 | 108 | No | 14 | 4 | 56 lbs. | 120 | 240 | 480 | Groups of 9 stacks, 4′ spaced between groups, for fire precautions. |
| | N.I.V. | Army Track | Stacks of 5 layers, 8 rolls per layer, 10′×10′×6′ high | 15000 | 2500 | Rolls | 560 | 1/6 | 94 lbs. | 2 rolls | 6 rolls | 12 rolls | Batten every layer for easy handling. |
| | N.I.V. | Nissen Huts | Stacked in bays of component parts (One can be stacked in area 16′×12′) | — | — | No | 2-ton 5 cwt. | — | — | — | — | 1 | Without flooring. |
| | N.I.V. | Timber Huts | Size 54′×16′, 4 stacks 8′×6′ per hut in sections. Extra space for handling gives 220 sq. ft. per hut | — | — | No | 9-ton | — | — | — | — | 1/3 | 3 No. 3-ton lorries per hut. |

*COMPOSITE LOADING TABLE.*

| Classification. | Items forming composite load. | No. per 30-cwt. Lorry load. | No. per 3-ton Lorry load. | No. per 10-ton Railway wagon. | Remarks. |
|---|---|---|---|---|---|
| Defence stores | (a) *Wiring.* (Triple Dannert) | | | | *N.B.* 30 cwt. carries stores for erection of 250 yds. triple Dannert Fence. 3 tons carries stores for erection of 400 yds. triple Dannert Fence. 10-ton Railway wagon carries stores for erection of 500 yds. triple Dannert Fence. |
| | Screw pickets, long ... ... | 130 No. | 208 No. | 278 No. | |
| | Wire, Dannert ... ... ... | 45 coils | 72 coils | 100 coils | |
| | Wire, Barbed (28 lbs.) ... ... | 5 coils | 8 coils | 10 coils | |
| | (b) *Revetting.* | | | | |
| | Pickets, wood, long ... ... | 50 | 100 | 250 | |
| | Pickets, wood, short ... ... | 50 | 100 | 250 | |
| | Hurdles ... ... ... ... | 20 | 40 | 100 | |
| | Binding wire ... ... ... | 1 coil | 2 coils | 5 coils | |
| | (c) Sandbags ... ... ... | 4000 (4 bales) | 8000 (8 bales) | 12000 (12 bales) | Bulk of material is the limiting factor. Figures for wagon based on box-type. |
| | Picks ... ... ... ... | 20 | 40 | 80 | |
| | Shovels ... ... ... ... | 20 | 40 | 80 | |
| | Wheelbarrows ... ... ... | 2 | 4 | 6 | |
| | (d) C.G.I. sheets ... ... | 30 3 bales of | 60 | 120 | Figures for wagon based on use of box-type. |
| | "A" Frames, small ... ... | 30 ten per bundle | 60 | 80 | |
| | Duckboards ... ... ... | 30 (per bundle) | 60 | 80 | |
| | (e) Netting wire ... ... | 17 rolls | 35 rolls | 50 rolls | |
| | X.P.M. ... ... ... ... | 50 sheets | 100 sheets | 400 sheets | |
| | (f) Pickets, wood, 6′ ... ... | 100 | 100 | 400 | |
| | Pickets, wood, 2′6″–3′ ... ... | 100 | 200 | 400 | |
| | Wire G.I. 14 G. ... ... | 1 cwt. | 2 cwt. | 4 cwt. | |
| Camouflage | Hessian canvas patches 48″ ... | 7 | 10 | 30 No. | Box-type wagon to be used for these stores. |
| | Nets camouflage ... ... | 35 | 50 | 170 No. | |
| | Strips garnishing ... ... | 20 | 30 | 100 bundles | |
| | Steel wool ... ... ... | 8 rolls | 12 rolls | 30 rolls | Bulk of material limiting factor. |
| | Cullacoats Feathered Netting | 8 rolls | 12 rolls | 30 rolls | |
| Road improvised | Army track ... ... ... | 6 rolls | 8 rolls | 14 rolls | Bulk of material is the limiting factor. |
| | Coir matting ... ... ... | 6 rolls | 8 rolls | 14 rolls | |
| | Pegs ... ... ... ... | 300 No. | 400 No. | 700 No. | |

COMPOSITE LOADING TABLE—*continued*.

| Classification | Items forming composite load | No. per 30-cwt. Lorry load. | No. per 3-ton Lorry load. | No. per 10-ton Railway wagon. | Remarks. |
|---|---|---|---|---|---|
| Conservancy | (a) *Latrines.* | | | | |
| | Poles 10 ft. | 20 No. | 40 No. | 50 No. | |
| | Lashings 1" | 20 No. | 40 No. | 50 No. | |
| | Hessian | 3 rolls | 6 rolls | 10 rolls | |
| | Nails 1" to 6" | $3\frac{1}{2}$ cwt. | 7 cwt. | 10 cwt. | |
| | Hammers, Sledge | 2 No. | 6 No. | 12 No. | |
| | Hammers, Claw | 4 No. | 10 No. | 20 No. | |
| | Spare Helves | 4 No. | 10 No. | 20 No. | |
| | Picks | 25 No. | 50 No. | 75 No. | |
| | Shovels | 25 No. | 50 No. | 75 No. | |
| | Sheets, C.I. | 50 No. | 100 No. | 150 No. | |
| | Paint | 20 gallons | 40 gallons | 100 gallons | Colour dependent on the type of country. |
| | Brushes | 6 No. | 12 No. | 12 No. | |
| | Mauls | 3 No. | 10 No. | 20 No. | |
| | Pails G.I. | 4 No. | 8 No. | 12 No. | |
| | (b) *Cookhouses.* | | | | |
| | 3" × 2" Timber | 300 ft. | 700 ft. | 1000 ft. | |
| | 9" × 1" Timber | 100 ft. | 300 ft. | 750 ft. | |
| | Nails, G.I. | 3 cwt. | 6 cwt. | 10 cwt. | |
| | Pails, G.I. | 4 No. | 8 No. | 12 No. | |
| | Paint | 20 gallons | 50 gallons | 100 gallons | |
| | Cement | 3 cwt. | 3 cwt. | 3 cwt. | |
| | Picks | 6 No. | 12 No. | 25 No. | |
| | Shovels | 6 No. | 12 No. | 25 No. | |
| | Mauls | 3 No. | 6 No. | 12 No. | |
| | Sheets, C.I. | 50 No. | 100 No. | 300 No. | |
| | Roofing felt | 3 rolls | 6 rolls | 12 rolls | |
| | Bricks | 50 | 100 | 200 | |
| | Reinforcing Bars 1" (1' 6" long) | 20 | 40 | 40 | |
| | Lashings 1" | 6 | 6 | 6 | |
| | (c) *Billets.* | | | | |
| | Blackout material | 4 rolls | 8 rolls | 16 | |
| | Stoves (complete) | 2 | 4 | 8 | |
| | Hessian | 4 rolls | 8 | 16 | |
| | Paint | 20 gallons | 40 gallons | 100 gallons | |
| | Brushes | 6 No. | 12 No. | 24 No. | |
| | Timber 1" × ¾" | 1000 ft. | 2000 ft. | 4000 ft. | |

*SPECIMEN WORKS TICKET.*

REQUISITION FOR WORKS. Sheet No. 1

Required by.................................... Job. No..............................

| Quantity required. | Description. | PRIORITY. |
|---|---|---|
| | | URGENT.<br>NORMAL. |

| | |
|---|---|
| Date { Received ...................<br>Commenced .................<br>Completed ................. | On completion { to be called for ...........<br>to be sent to ................. |

N.C.O. i/c Job............................ Major, R.E.

Commanding X Corps Field Park Coy, R.E.

Sheet No. 2

(To be placed on reverse of Sheet No. 1)

| Materials drawn. | Materials used. |
|---|---|
| | |

| Personnel | | Man hours. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rank | Name | | | | | | | | Total |
| | | | | | | | | | |

Total : Officer i/c Workshop......................

## *THE SITING OF A DIVISIONAL FIELD PARK COMPANY.*

*By* MAJOR W. H. AYLWIN, R.E.

ON the efficiency of a Divisional Field Park Company depends, to a considerable extent, the execution of the normal engineer work required to allow the Infantry Division to live, move and fight.

Good organization within the Company is of course essential but it is suggested that careful siting of the various sections is a prime consideration, without which even the best organization will be severely handicapped. If this can be proved, it is submitted that it will be well worth while spending considerable time and thought on the choosing of the location before any start is made on the actual work of the unit.

The problem is set out in *Engineer Training, Part II*, which defines the role of the Divisional Field Park Company as follows :—

(i) To carry the Division's reserves of tools, bridging equipment, engineer plant and stores.
(ii) To organize and man divisional engineer workshops and dumps.
(iii) To operate the divisional H.Q. lighting set.
(iv) To provide a reserve of skilled tradesmen.
(v) To serve as the channel for the supply of engineer stores (other than replacements of unit equipment).

It is proposed to discuss here only the siting requirements under static conditions of warfare since, not only is it a far more difficult problem, but in mobile warfare the C.R.E. and Field Park Commander can only endeavour to approximate as nearly as possible to the desiderata set out below.

There are some general considerations which will have to be taken into account before reviewing the requirements of the various sections of the company.

Firstly, it is highly desirable that the Field Park Company should be centrally placed with regard to the Field Companies. If this is not done, fair dealing is hard to ensure, since the nearest company will tend to have first pick of the good things as they arrive and the less fortunate companies will waste many lorry-hours on their long stores journey. In this connection it should be noted that to site the Field Park Company in the geographic centre of the Field Companies is not necessarily the correct answer. To equalize the road distances is the real requirement.

Secondly, the accommodation of the Field Park personnel is of considerable importance. They must live near their work, otherwise much precious time will be wasted. The accommodation and recreational facilities should be the best obtainable. There is little change or glamour in the lives of most Field Park men, who grind on day after day at their respective jobs, and maintenance of their morale is of the highest importance.

Thirdly, air attack is probably the chief enemy of the Field Park and consequently dispersal is most desirable. However, as will be seen later, this militates against many other requirements and a balance will have to be struck in most cases. It should be borne in mind that dispersal also complicates the guard problem which is always one of the O.C's difficulties, as his margin of man-power is very slight. However, a great deal of assistance in overcoming the need for wide dispersion can be obtained from the use of a carefully thought-out concealment plan. By this it is not implied that everything must be under cover but rather that the Company's activities should be so controlled that, to the airman's eye, the neighbourhood does not contain anything of military importance. This entails a study of the normal life of the town or village and a big effort to blend with it. A great deal can be done by the intelligent siting of, say, Nissen Huts and the avoidance of the "photographic mess" which is unfortunately such a feature of the British Army at the moment.

With these considerations in mind, let us now review the requisites for siting the various sections of the Field Park. The Company Office and its staff should be on the main road or at least very close to it. It should not, however, be near the dump or it will (*a*) degenerate into a coffee house for all and sundry who call for stores and (*b*) be caught up in the hundred and one minor points which arise in the course of the day. On the other hand, it is a great advantage to be in telephonic communication with the dump office in order that priority decisions, etc., can be given without delay. The fact that no telephone equipment is carried by the Divisional Field Park Company should be no deterrent to its Commander, who is in a very strong position as far as barter is concerned!

In choosing the H.Q. site, the provision of a drawing office should not be forgotten. It is most unfair to expect the draughtsman to work well if he is tucked away in a dark corner of a noisy office. He should be given a well-lighted (both by day and by night) room and every reasonable comfort, including suitable warming arrangements. As a race, draughtsmen are keen workers and, given the right encouragements, will produce drawings which will at least ensure that the work starts right.

Turning to the Workshop Section, we again find some conflicting requirements. For instance, it is most advantageous if a saw-mill and a metal-work shop can be requisitioned but, on the other hand, unless the workshop is adjacent to the dump every scrap of material will require double handling. As ever, it is a case of weighing up the pros and cons and producing the best answer to the particular problem presented by each location.

Ease of access is most necessary for the workshop. Not only is it important that materials can be brought right up to the door on wheels but also turning space and storage space must be immediately available. In this connection, due thought should be given to the very serious problem of the danger from fire.

The Bridging Section usually presents an easier task. It is not necessary—in fact it is in some ways undesirable—that it should be located near the dump. The main point is the need for concealment. The large number of easily recognizable lorries makes this aspect most important but skilful use of buildings as cover, assisted by the unit camouflage equipment, can work wonders. Care should be taken, however, that the various types of bridges are kept together, otherwise a quick turn-out will be considerably hampered. Apart from the above the chief points to note are the need for good hard standings, the necessity for adequate dispersion as a counter to bombing and fire risks, and the provision of the means of quick exit for, if possible, each individual vehicle.

Lastly, the Field Stores Section requires, perhaps, the most careful siting of them all. Good road access is a *sine qua non*, since a large proportion of the incoming stores and probably all of the outgoings will be moved by M.T. The site of the dump itself should be level, free from obstructions, and—most important—well drained. Piles of stores surrounded by a morass entail a large amount of arduous man-handling, with consequent delay. Good covered storage must also be available for stores, such as cement, which are likely to be damaged by the weather.

Access to the railway is most important. In fact, a spur running into the dump is practically vital, as all heavy stores will arrive by rail and, without a spur, double handling will become necessary, with all its attendant disadvantages. If possible, the spur should be double-tracked in order that empty trucks can be sidetracked until an engine is available to take them away.

Where, as on the continent, a network of waterways is available, a large amount of bulk stores, such as sand and aggregate, will arrive by barge. Hence easy access to a quay is a great advantage. In this connection the local availability of grabs and cranes should be investigated.

Fire, especially in these days of "Firebomb Fritz," is an ever-present danger to store dumps, so that water-supply facilities should not be overlooked. The odd petrol tin of water is of very little value and every effort should be made to avoid the necessity for the erection of large water storage tanks by getting as close to some form of water-supply as possible.

From the foregoing, it will be seen that the choice of site for a Divisional Field Park Company should not be treated lightly, since it can prejudice or enhance the chances of the Company fulfilling its task efficiently. Unless the Field Park does work efficiently, the Field Companies will at least be hampered and unless they are working well the Division will certainly not live, move and fight as well as could otherwise be reasonably expected. It is therefore urged once again that "time spent in reconnaissance is seldom wasted."

# "COURSING."

*By* MAJOR E. S. DEBRETT, R.E.

OF the making of Training Programmes there is no end. In Peace we train—keenly—for War: in War we train—urgently—for War (and by correspondence courses—for Peace): in Victory we shall train to allay the boredom of armies of occupation.

It must be the lot of every Officer to concoct a Training Programme during his career. Sometimes he gets plenty of notice—sometimes little. How often has the Section Officer been faced with this situation:— Time—Saturday, first parade. O.C. says "I've just got a message from the C.R.E. The materials for that job of yours will be on site a week late. There are no other jobs to be done so far as I know. We haven't thought about water supply lately and the whole Company will have to fire a full range course soon. You've probably got a few things to tidy up as well. Now I must nip off to H.Q. for a conference at 9 o'clock and I shall be back late. Goodbye." Section Officer smiles wanly and salutes. Words fail him—all his well-laid plans gone west.

This happens, in varying degrees, to all commanders. Now all good commanders, being wedded to their commands, know their spouse's faults to a nicety, though some may be a little blinded by love. But how many have up their sleeves a ready-made Syllabus and Programme to fit the exact needs of the moment?

So perhaps the experiences of an O.C.T.U. staff, who have built a programme and re-modelled it twice in six months, both for reasons beyond their control and as a result of trial and error, may be of some use, if only in preventing others from making the same mistakes.

## TYPES OF COURSES.

There are various types of courses and the first step is to determine the type which you have got to run.

1. The "little about a lot" courses. These embrace cadet's, recruit's and other general courses for those who have little or no knowledge to start with. They cannot teach the details, or practise the students fully, in all the subjects which must be packed into them. It is easy to know where to start, but the difficulty is where to finish. They can only lay foundations and give direction for further building by bitter experience or study.

2. The "lot about a little" courses. These are specialist courses for those who should possess fundamental knowledge. The difficulty here is where to start. What is fundamental? How much will students know on arrival? If the course is for N.C.O's in your own unit or formation you can make a pretty shrewd guess, if not you must lay down a standard. The end is easy—everything.

3. The "bring 'em up to date" courses. These range from junior N.C.O's cadre classes, through refresher courses of all sorts, to the Senior Officers School. The main thing in these is to ensure that the latest doctrine is taught and the newest problems brought out in schemes and discussions.

4. The "Practice makes Perfect" course, which is really unit or formation training, and calls for clear thinking-out of lessons and much imagination in devising exercises to bring them home.

5. "Conference" courses. These are for Very Senior Officers only, so I dare say nothing about them, but I suspect that weighty deliberations on "future developments and policy" play a large part in their make up.

### OBJECT.

The type of course is very often decided by higher authority. All, except the last, come within the scope of the unit commander, who must make up his mind about this before he can take the next step, which is to define the Object—a tiresome mental process, common to all military functions, meaning "getting down to brass tacks."

In our particular case much was decided for us by a benevolent War Office. The number of subjects inevitably made the course Type 1. The object was, briefly:—

(*a*) To instil the basic knowledge of Military Duties, Motor Transport and Elementary Fieldworks required by an R.E. Officer in Transportation and L. of C. Units, into 52 out of every class of 55 Cadets. (What a hope !)

(*b*) To develop Officer qualities and weed out the unfit.

### FACTORS AND PLAN.

1. This seems to be developing on orthodox lines, so the factors must be taken next. First comes our old enemy Time, followed by availability of instructors, subjects, output of students, training equipment, accommodation and others in varying degrees of importance.

2. The interplay, relative weight and deductions from these factors lead, as in all good appreciations, to the *Alternative Plans* (can't have courses in again as we are considering courses anyway, and courses of courses would of course lead to confusion).

There are probably many possibilities. Having taken the plunge on one of them *The Plan* must include decisions on the following points :

(*a*) Hours of work.
(*b*) Division of whole course into sub-courses.
(*c*) Sequence of subjects (logical, if possible).
(*d*) Allotment of subjects to sub-courses.
(*e*) Allotment of subjects to instructors, if not already done by appointment.
(*f*) The scope, not the detail, of the Syllabus in each subject.
(*g*) Allotment of periods to subjects.

3. At this stage the originator, be he Chief Instructor, Adjutant, Specialist or any bottle-washer whatever, can resort to decentralization. Oh ! blessed word. This has obvious advantages. It ensures that instructors get really inside their subject. It brings to light quickly fundamental impossibilities in the plan, *e.g.*, the impossibility of covering (*f*) with (*g*). It allows the head man to chase up a thousand and one things which have to be arranged before the course can start.

4. So much for generalities. Here follows an egotistical description of the steps *we* took to build up *our* programme. (*Reader* "Conceited . . ." *Author* Ah ! Wait till you read the *Snags*.")

5. For Staff we were sent a representative side from all sections of military and civil life. The C.O. was a University Tutor, a man of profound wisdom and broad outlook, who had started his Army career before the last war in the Special Reserve. The Chief Instructor a regular of the third generation, bound by tradition and old school ties, and shut in by the narrow outlook of hidebound Toryism. "The Adjutant" was imported by the goodwill of a sister O.C.T.U. and so had all the procedure at his finger tips. The Instructor of Tactics a regular University Entrant with Staff College aspirations, who, by his constant conviction that none of the Cadets would ever become officers, put the brake on some of his more sanguine and charitable colleagues. Instructor of Field Works, Instructor of Map Reading and Instructor of Mechanical Transport were all Scots and highly qualified and experienced civil engineers. The I.F.W. had a T.A.R.O. commission, a sour expression hiding a humorous mind and the gift of cruel caricature which effectively squashed any claims to good looks by the Staff.

The I.M.R., an early O.C.T.U. product, combined musical ability and a passion for climbing mountains with a strictly practical outlook where his job was concerned. The I.M.T. had commanded the R.E. Unit of the Glasgow University O.T.C. in peace and had a rare gift for lecturing on what can be a very dull subject. The two Assistant Instructors were both commissioned from the ranks of the regular peace-time Army. The Class and Administrative Officers were from equally diverse sources, so that all shades of opinion were represented and any bias towards extreme views was effectively checked.

6. As accommodation we had the derelict house and grounds lately the property of a colliery owner, who had not hesitated to undermine his own home in his search for wealth. The tottering house became the Officers' Mess. The Local Authority had acquired the property shortly before the war and had partly completed a school for mentally deficient children in the grounds. This was taken over for the Cadets, who therefore started with every advantage. The thickly wooded grounds screened us effectively from the surrounding industrial grime, and made a remarkable and pleasant retreat. Much repair and reconstruction was needed and nothing had been done when the Staff began to assemble.

7. Time had been fixed at 3 months and the intake of Cadets at 55 a month.

8. Equipment, for once, was not a factor, as we had to make out our own table—of which more anon.

9. Our plan was to have three courses, each of a month.

The motif for course (*a*) was military duties played *fortissimo* by all instruments. In course (*b*) the main theme was given to the M.T. horns while the military duties continued *diminuendo* in the background. In the last movement the main subject was F.W. with strong percussion accompaniment and a faint echo, *pianissimo*, of military duties.

The full score is given in Appendix A.

### The Programme.

1. This consists of two parts, Syllabus and Time Table. These bear some relation to one another on the best courses. It is compiled to provide a basis for amendments or to be torn up. It is never perfect. Before starting to work it out in detail, several things must be collected :—

(1) Blank pro-forma on tracing linen.
(2) An india-rubber which can't get lost.
(3) A hermit's retreat in which to work.
(4) A dictatorial mind.
(5) Wet towels and beer.

We had at our disposal the programmes and experience of the other R.E. O.C.T.Us. and most valuable they were. We differed, however, in two ways :

(*a*) We had in 12 weeks to cover subjects for which they took 16 weeks.
(*b*) M.T. was not of such vital importance to the branches for which we had had to train as for the Field Units. Although we were the same in that a uniformly high standard of knowledge on Military and Elementary F.W. subjects is required throughout the Corps.

Owing to (*a*) compression all round was necessary. This inevitably led to vociferous protests from all instructors, who were told (see item 4) to produce a Syllabus to fit the periods.

2. Whilst A.Is. were doing this, the C.I. rushed round Area and Command H.Q.'s trying to induce people to believe that we were really in existence and would shortly have to start training Cadets. Also that this would involve the provision of a modicum of accommodation, material and equipment.

3. In spite of their assertions to the contrary, the instructors rapidly produced Syllabi which covered their subjects in the allotted time. They also showed whether periods were needed in blocks or singly, practical or lectures.

The C.I. then retired to (3) above, taking with him (1), (2) and (5), what time the instructors got down to the detailed preparation of lectures and *précis* (to be submitted for approval to C.I., who had to make a pretence of exercising some control). They assumed that Cadets would have *no* knowledge on arrival.

3. The building of a three-months time table covering a number of subjects with a few instructors needs careful planning, for one must remember :—

(*a*) That only a man of exceptional ability can deliver two lectures in different class rooms at the same time.

(*b*) That lecturing for 9 periods consecutively is tiring and sleep-inducing.

(*c*) That subjects should be dealt with in blocks subject to the limitations of *a* and *b*.

(*d*) That P.T. before breakfast and immediately after dinner is unpopular with instructors, men, and the Medical faculty.

(*e*) That Cadets are not quick-change artists.

(*f*) That enough Officers must be available for the D.S. on T.E.W.Ts.

(*g*) That—oh well—that the beastly thing *will* run for 3 months in spite of a "*slip*" period of a week and without having to be torn up and re-written weekly.

The "*slip*" is a longer interval than the normal one between intakes. It allows for reconstruction, leave and so on.

4. The following method of construction is recommended :

(*a*) First blank out all useless periods like Saturday afternoons, Recreational Training, Educational lectures (oh dear ! What has he said ?) and then place the large blocks of T.E.W.Ts., Recces., E.E.W.Ts., M.R. and Practical F.W. firmly in their logical position. If these occur under the same instructors in successive courses, superimpose weeks which will run together (*don't* forget the "*slip*" period "Oh best beloved") making sure that they break bond. Then arrange the appropriate lectures in small blocks before exercises.

(*b*) An additional check is provided by keeping a "personal programme" for each Instructor and filling in a blank each time he appears. This will also ensure that, although his subject may not be running for too many consecutive periods in one course, he is not in fact lecturing for too long a stretch.

(*c*) Finally grout together with a slurry of Physical Training, Drill, Weapon-Training, Organization and Administration, Military Law, etc., constantly making sure that bond is broken and keeping a check on the N.C.O. instructors, who will have to specialize to a certain extent.

(*d*) A few voids should be left here and there so that the decorative touches provided by Gas, Cooking, Agriculture, Hygienic, National Savings and other monumental experts may be added in due course, and to give elasticity.

This structure should withstand the buffetings of any weather and need only be re-built after a cataclysmal change of policy of some sort.

Temporary amendments are subsequently circularised and written on celluloid overlays—permanent amendments are entered on the sheets themselves.

*Equipment.*

1. The Unit hatched rapidly. It was fully fledged before the equipment scale was formally approved. It had not been possible to make the scale out in detail until the detailed programme had been evolved. The training grant and the scale of books were naturally in the same state.

2. The lack of equipment scale made it difficult to draw from Ordnance, even when they were not too busy "mobilizing someone else" and the article

was in stock. W.O. saved the day with a "carte blanche" teleprinter which was waved under the noses of the incredulous. With the aid of this a considerable amount of equipment was collected in time by legitimate means.

3. The gaps were filled by begging, borrowing and stealing from neighbouring Units and Contractors, so that we never lacked for anything, though there were a few nerve-racking moments, wondering whether things would arrive in time.

4. We finally got what we asked for and our table was written from it. We made a guess at the training grant. It proved optimistic but we were able to divert our raw materials and avoid a "blow back."

*Training Methods.*

1. The need for covering a lot of ground and ensuring a grasp of basic principles leads to the adoption of lectures as the basis of instruction. The disadvantages of this system have been pointed out countless times in this *Journal* so I won't reiterate them. However, this was the accepted principle at the time and as we could not devise anything better we followed suit. Instructors prepared lectures and *précis*, which were designed to bring out the main points and were fully referenced for further study. *Précis* were all submitted to C.I. to try to ensure that there were neither overlaps nor omissions. A few points were tactfully left for correction. Lectures were timed to leave 5–10 minutes for discussion and a few periods were allotted for discussion of specific points.

2. Soon after this system had got under way we began to see, as instructors, the defects from which we had all suffered and about which we had all read. We started to think out improvements. There were signs that the official view was that something should be done about it. Finally, the edict went forth that the voice of the instructor was heard too much in the land, that lectures were an abomination and that instruction would in future be by tutorial methods and Socratic discussion. We heartily agreed with this opinion. But it was a bit of a facer all the same because :—

(*a*) The economical group for discussion is not more than 12 and our Staff was quite inadequate to cope with that size of class, however general knowledgeable they all might be.

(*b*) Discussion envisages a nodding acquaintance with the subject on the part of the discussers, if any headway is to be made. Our assumption that the Cadets' minds would be unsullied by too much military knowledge was quite correct.

(*c*) Experience showed that a lecture could cover 7 or 8 points in 40 minutes, whereas discussion covered only 3 or 4, and it was never quite certain whether Cadets absorbed the nonsense which might be spouted by another Cadet or the correct summing-up of the discussion leader or instructor. The solution was an increase in staff or a longer course or a cut in the syllabus. None were possible, for reasons which are irrelevant.

3. Nothing daunted, however, it was decided to experiment with the whole of the Organization and Administration in the Field. The *précis* were dished out in a lump to try to direct study into the correct channels. Private study was done at set times in classrooms and instructors were present to solve individual difficulties. The available time was divided into 3 parts private study to one part discussion of topics set from cadets' suggestions. Experience from this showed :

(*a*) That very few questions were raised during P.S. because students did not know what their difficulties were.

(*b*) That, though parrot knowledge was good, there was little grasp of underlying principles both in discussion and in the written exam.

(c) That this method produced a generally lower standard of all-round knowledge and was less popular with the cadets than the lecture-*cum*-short-discussion principle.

The conclusion reached was that the most profitable division for a subject of this sort would be 1 part lectures on fundamental principles (if these can be defined !), two parts private study and one part general discussion. This method was adopted for other subjects after this initial trial.

4. Another gambit was successfully tried for subjects on which nearly everyone has ideas, but for complete knowledge of which a lifetime of study and experience would be needed. "The Art of Lecturing" and "Officers' Responsibilities" are two which suggest themselves. It might be called "The strictly limited discussion" and the moves are as follows :—

(a) The instructor prepares a lecture and a *précis*.
(b) He thinks out a series of questions which will produce the answers, which he wants, as a conjurer induces an unbelieving stooge to produce rabbits from an apparently empty hat.
(c) He gives the class a few minutes to think out and jot down ideas on the subject, which he has introduced very briefly.
(d) Now comes the metaphorical hat in the form of questions out of which someone in the class must pull a rabbit.
(e) Sometimes a black rabbit is produced when a white one is wanted or is an alternative. The wizard may rapidly produce the white one himself or pass the hat on, depending on the time available.
(f) The answers are chalked up and the *précis* appears on the board. When the performance is slick this method covers the same ground in 40 minutes as a lecture of 30 minutes and 10 minutes of questions. It has obvious advantages over the lecture. It avoids the liability to irrelevancy and discursiveness in the unlimited discussion, which is unmanageable in a class of the size with which we had to deal.

5. Subjects like Fieldworks, in which there is a definite right and wrong line of action, can be treated like that well-known game "The Priest of the Parish" for Revision.

Mr. "A" starts on his dialogue. He may be "watched" or "checked" by anyone who thinks he has made a mistake. If the watcher is right, Mr. "A" is deposed; if wrong, Mr. "A" may pour scorn on the interruption and continue.

We have not yet introduced "fillips to the buntoon," as a penalty, though I have often wished that the application of a rope's end was legal tender !

6. Some difficulty was experienced in muzzling the N.C.O. instructors, who had all been used to putting recruits through the mill. Cadre classes were run during their free periods and they soon readjusted themselves to methods designed to bring out confidence and cultivate the seeing eye.

7. The difficulties in imparting knowledge are as nothing compared with the problem of teaching leadership and developing that all-embracing quality called "character."

That the first can be learned and the second developed is certain. The need for both have been stressed times without number in training literature, but how the trick can be done in practice is a matter on which a discreet silence is kept. I shall not be rash enough to break it.

Four things, however, are certain :

(a) That many young men come from jobs in civilian life where opportunity for leadership is nil.
(b) That some have had little practice while in the Army.
(c) That the seed of leadership exists in some degree, if the fruit is only leading others into trouble, in every man.
(d) That these qualities cannot be fully grown in 3 months.

Therefore, whatever methods are used to cultivate these delicate plants of the mind, the soil of opportunity must be provided. They can be fertilized with encouragement; they must be pruned with uncompromising candour and they can be guided by example.

### The Students.

1. There are few more pathetic sights than the new boys at school, and Cadets are in much the same class. They suffer from the additional disadvantage of being shorn of their protective stripes and being girt about the head with a white girdle, the significance of which has never been really understood.

If it was intended to denote that the brain within the band was virginally pure from military knowledge, it was aptly designed in the majority of cases.

2. A large proportion came from the hastily-formed Units which had rushed abroad at the beginning of the war. The students had often done no recruit training and very little military training thereafter, owing to the pressure of technical work.

The instructors generally began with much headwagging and depression, followed by a burst of enthusiasm as they realized that there were some intelligent members of the class (" Hmmmm! not so bad after all"). Opinion then waxed and waned in proportion to the number of blobs made in tests and exercises.

3. The Cadets' reactions to the course were tried at intervals and many useful suggestions came from them. They were told at the beginning to take an objective interest and full consideration was always given to their ideas.

They quickly settled down and it was interesting to see how each class took on its own character and how the influence of a few outstanding Cadets leavened the whole lump.

4. Individual character and ability were carefully watched. The general system was borrowed from another O.C.T.U. Each Cadet was told of any fault by the instructor concerned. His name was circulated to all instructors, together with his particular weakness, which he was helped to eradicate. Some were quickly cured, some only yielded to prolonged treatment, some were uncurable and were cast into outer darkness.

5. Every effort was made to prevent the fear of rejection from casting a blight over the Unit. The whole system was explained to Cadets on arrival and as far as could be seen they were not unduly subdued. They worked like niggers. There were 9 periods a day except Saturdays, in addition to which most Cadets averaged 20 hours a week reading in their own time. They were worked into quite a good shape in 3 months and an extra month would have produced a rather more finished article.

*Snags.*

1. In spite of all efforts, gaps and overlapping were found in the programme. The gaps were partly due to a lack of understanding of Cadets' difficulties and these only came to light as the result of tests and a *questionnaire* which was discussed during the last week.

2. Experts on all sorts of subjects bobbed up at intervals with lectures and demonstrations, which had to be fitted into an already overpacked programme. This gave rise to a spate of " weekly amendments." On the whole the standard programme worked fairly well and few permanent amendments were made. It would have been better to allow more " spare " periods than we did.

3. The overlaps had to be cut away and the edges of Tactics, Weapon Training and Field Works which merged had to be watched for contrary teachings. There were only one or two instances of " Oh but, Sir, Capt. X told us So & So! "

4. Another difficulty was to blend the fashions in drill and weapon training

which were sported by instructors from the various training battalions. Long and acrimonious were the arguments about the relative merits of this pause or that pause and whether the course of the war would be seriously upset if permission was asked to "Dismisssirplease" or "Breakoffsirplease" or *vice versa*. These were settled during cadre classes periods and uniformity established.

5. After three months trial we came to the conclusion that the course suffered from three major defects:

(*a*) The M.T. course (*B*) gave a little work out of mental meal times, while the F.W. course (*C*) was highly indigestible. Course (*C*) gave good opportunities of gauging character, while (*B*) did not.

(*b*) There was too little time given to training in ability to "hold the floor" though every Cadet talked a good deal during T.E.W.Ts., etc., and no attention was paid to training the individual in this respect.

(*c*) The emphasis on various individual subjects was unbalanced, *e.g.*, the practice in Recce. inherent in T.E.W.Ts. & E.E.W.Ts., was not enough to produce good results—there was no practice in applying the principles of Unit Administration, etc , etc,

These called for drastic reorganization, which was tackled during a low period in our activity. In fact it was a period of almost suspended animation, except for one brief moment of violent palpitation, when we were threatened with expansion to double our previous best output.

6. The programme as re-arranged (Appendix B.) tried to overcome these defects (*a*) by running M.T. and F.W. parallel over the last two courses B. & C., (*b*) by introducing a number of "lecturette" periods large enough to allow each Cadet to give a 15 minute talk, with 7 minutes' criticism thereof, (*c*) by dealing with Recce. as a separate subject, over and above Engineer Recce. which was already included, followed by a number of non-technical practical Recces. of gradually increasing complexity. By making Cadets command detachments when every imaginable administrative snare was laid. The second remodelling, to which I referred at the beginning, was on account of changes in establishment, which never materialized.

### THE TEST.

1. Something must be done to see whether the course is doing its job. It is possible to learn a good deal from the students themselves at the end of the course and a few months after they have left, also from their commanding officers.

Whether or not we have managed to teach anything useful is a matter which only time will show.

2. We have assuredly collected many gems of wisdom from the Cadets. Among other novel ideas we learned that "the D.A.A.G. is split up into 1st and 2nd echelons," which must be a painful process. That "the R.A.P. was where drinks are served" and thereafter a casualty descends to "C.C.S. where the A.D.M.S. may or may not operate." There was an old Shop tradition that the temperature of the M.O's bath water had a direct bearing on his diagnosis and prescription, but the factors which sway the A.D.M.S's inclination are unknown.

That the medium R.A. had troupes, which, presumably performed twice nightly.

That our tactical teaching has many defects is shown by the fact that "Vanguards, Flankguards and Rearguards should be provided for the protection of the enemy," a rather more altruistic outlook than our present one. The following might serve as the "height of pessimism." . . . "Before moving up to the attack I would remove all equipment except identity discs, while the "height of optimism " was reached by the Cadet who painstakingly bound the leads of an electric detonator to a piece of safety fuze.

The entrance maths. test produced many good answers including " Dear Sir, the Cadet on my right has one answer and on the left another so I won't attempt to cheat but must admit defeat."

The following amendments should be made to any dictionary of technical terms:

" Dog Legs "—A system of 3 poles used in conjunction with a tackle.

" Spit Lock "—Metal portion to hold an oar on a pontoon.

" Scales "—As a rule it is impractical to print maps the same size as the real thing . . .

(We heard there was a paper shortage)

" Vertical Interval "—The distance between latitudes expressed in degrees minutes and seconds.

" Horizontal Equivalent "—As defined above but applied to longitudes.

That Cadets experienced many unimagined difficulties is instanced by the following questions:

" Please, sir, where a river crosses a contour line does it run underground or is there a waterfall ? " (" Layered " ground ?)

" Shouldn't zero hour be included in the Coy. Comdrs. orders for the defence ? " (Kick off 2.30 p.m.)

" Does a lump of electricity run round the circuit and when it hits the gap in the plug, jump it ? "

In conclusion, there is no doubt that Cadets grew in stature during the course and that even 3 months' training gave them an advantage over the directly commissioned Officer.

Allotment of Periods to Branch of Training.

Appendix " A."

*Preliminary.*

| | |
|---|---|
| P.T. | 2 |
| Drill | 1 |
| Examinations | 2 |
| Interviews / Preliminary Lectures / (Excluding day of arrival) | 8 |
| | 13 |

*Course " A."*

| | |
|---|---|
| Spare | 9 |
| P.T. | 18 |
| General Education | 4 |
| Drill and B.F. | 34 |
| Weapon Training | 28 |
| Tactics, O. and A. | 74 |
| Unit Administration | 8 |
| Map Reading | 13 |
| | 188 |

*Course " B."*

| | |
|---|---|
| General Education | 4 |
| P.T. | 20 |
| M.R. | 20 |
| Drill and B.F. | 16 |
| Anti-gas | 12 |
| W.T. (Revolver and L.A.) and A.A. Defence | 12 |
| Unit Administration | 8 |
| M.T. | 70 |
| Tactics | 16 |
| Spare | 10 |
| | 188 |

*Course " C."*

| | |
|---|---|
| General Education | 4 |
| P.T. Drill and B.F. | 24 |
| Unit Administration | 8 |
| Fieldworks / Organization of Tn. Tps. / Engineer Recce. / Hutting and Water Supply | 130 |
| Military Law | 10 |
| Spare | 12 |
| | 188 |

APPENDIX "B."

*Course "A."*

| | |
|---|---|
| Drill | 19 |
| Weapon Training | 29 |
| P.T. | 18 |
| Bayonet Fighting | 6 |
| Gas | 6 |
| Tactics | 60 |
| Organization | 4 |
| Adm. in the Field | 11 |
| Unit Adm. | 4 |
| Map Reading | 16 |
| Reconnaissance | 7 |
| Miscellaneous | 3 |
| "Outside" Lectures | 4 |
| Spare | 1 |
| Recreational Tng. | 12 |
| | 200 |

*Course "B."*

| | |
|---|---|
| Drill | 10 |
| Weapon Training | 8 |
| P.T. | 8 |
| Gas | 7 |
| Tactics | 17 |
| Unit Adm. | 9 |
| M.T. | 30 |
| Fieldworks | 77 |
| Map Reading | 12 |
| Reconnaissance | 4 |
| "Outside" Lectures | 4 |
| Spare | 2 |
| Recreational Tng. | 12 |
| | 200 |

*Course "C."*

| | |
|---|---|
| Drill | 12 |
| Weapon Training | 12 |
| P.T. | 19 |
| Bayonet Fighting | 4 |
| Unit Adm. | 11 |
| M.T. | 35 |
| Fieldworks | 56 |
| Military Law | 10 |
| Map Reading | 4 |
| Miscellaneous | 3 |
| "Outside" Lectures | 4 |
| Spare | 6 |
| Recreational Tng. | 12 |
| Lecturettes | 6 |
| T.E.W.T. Setting | 3 |
| Tng. Programme | 3 |
| | 200 |

*Note.*—The extra 12 periods in each course are due to the inclusion of "Recreational Training."

# *MAPPING FROM AERIAL SURVEYS.*

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*Summary.*—Much has recently been written on the subject of aerial survey. Of this a good deal has been written or inspired by flying companies and those interested in the sale of equipment. Emphasis has mainly been laid on the ease and speed of the field work as compared with ground methods and the work involved in plotting has rarely been discussed. There is, therefore, a widespread impression that the flying and photography are the only considerable items in aerial survey and that the plotting is of negligible importance both in cost and in time. While it is not contended that the flying is unimportant, in fact good flying is the first essential and is by no means easy to achieve, the purpose of this paper is to point out what plotting really involves and to show that it is of greater importance than the flying.

## Field for Aerial Survey.

The selection of the method to be used for any survey should, normally, be based on the cost of obtaining and plotting the data desired. Sometimes the time factor is important, but this should not be the case in normal conditions with proper forward planning. Arguments based on relative accuracy and fullness of detail are fallacious, as with any method the required accuracy can be obtained. The greater the accuracy and the fuller the detail, the greater the cost.

The scale reduction in the finished map or plot may be taken as the measure of the accuracy and fullness of detail required in any survey. The plotting and reading errors vary directly as the scale reduction and set the required accuracy, while congestion of the map limits the amount of detail that may be shown. In mapping practice it is more usual to express scale reductions as ratios (*e.g.* 1 : 20,000) as this is independent of the units of length in use. However, to make the figures more readily comprehensible to those not used to this system, scale reductions will be expressed as "inches to the mile," etc.

There is no question that aerial survey has a great field of use in Australia. Partisans of aerial survey who press for its use under all circumstances are, however, doing a great dis-service to the cause they advocate. For certain mapping scales and conditions, aerial survey is economical and for others it is not. Map scales range from atlas scales of many miles to the inch down through all stages to detailed plans of engineering and other works with scales of a few feet to the inch. Under ordinary circumstances the smallest and largest scales are not suitable for aerial survey and are most economically carried out by ground methods, but the middle scales of about one mile to one-tenth mile to the inch are specially suited to aerial survey and should almost always be prepared in this manner.

These middle-scale maps are of extreme importance and their absence can easily result in unwisely planned and uneconomical work. Maps of this class are used for the preparation of the main outlines of all important works such as roads, railways, water conservation, irrigation, and power schemes, also of schemes for land use, timber and mineral development, etc. Without such maps expensive reconnaissance surveys are required for each projected work. In New South Wales they are available for a limited area only and the cost of their extension to cover at least the eastern part of the State would be repaid over and over again in a very few years. The scale of such maps, when undertaken, should be standardised and this would require consultation between all the future users and those responsible for their compilation. This selection of scale is most important and all the work, including the flying, should be carried out to suit the scale adopted and should not be commenced before it is settled. As a basis of discussion, for the remainder of this paper a scale of one-quarter mile to the inch has been assumed (this is probably of about the right order). On this scale a suitable contour interval is 50 ft. in hilly country and about 25 ft. in easy country.

In certain other cases aerial survey may be used for mapping, for reasons other than economy. The most important, at present, is for military purposes but it has also been used, in some countries, for urgent work in country difficult of access, where ground survey would have been more economical but too slow. For Australia the latter case is not an argument for aerial survey but for proper long-range planning.

Another extremely useful field for aerial survey, of less extensive application, is that of reconnaissance for a specific project. In this type of work mapping is not undertaken and, as a small area cannot be fitted into a large mapping work, a high standard of flying, such as is required for mapping, is unnecessary and uneconomical. In this work little or no plotting is attempted and the lie of the land is observed from mosaics or simple feature maps, assisted by stereoscopic examination of the photographs. For a reasonably large area the cost of such work is only one-third or one-half of the cost of topographic mapping and it is frequently adequate for the work in hand. From a national point of view it is, however, uneconomical; the flying is only useful for the particular job in hand and does not constitute a permanent asset. Also many jobs are too small to warrant a flight and are reconnoitred by expensive ground methods. It would be better to prepare, once and for all, topographic maps that would make most of such special reconnaissances unnecessary.

## Relative Cost of Flying and Mapping.

Present prices of flying and photography, for a scale of one-quarter mile to the inch, are about 25s. od. per sq. mile. This cost would be reduced if regular work covering large areas was available, and still further if modern wide-angle cameras were used. A reasonable figure under these conditions would be about 15s. od. per sq. mile.

Against this, the cost of production of a complete map to this scale, by aerial survey in average New South Wales conditions, has been estimated independently by the author, basing his calculations on data collected by the English War Office *re* times and man-hours and applying Australian prices and wages, and by a leading overseas flying and mapping company, on their own data, at £3 10s. od. per sq. mile.

This is divided approximately as follows :—

| | £ | s. | d. |
|---|---|---|---|
| Flying and photography .. .. .. .. .. .. | | 15 | 0 |
| Ground control .. .. .. .. .. .. | | 10 | 0 |
| Prints and reproduction .. .. .. .. .. | | 5 | 0 |
| Plotting .. .. .. .. .. .. .. .. | 2 | 0 | 0 |
| Total .. .. .. .. .. .. .. | £3 | 10 | 0 |

The comparison of plotting and flying can be shown in another way. Suppose it is decided to complete the topographic maps for eastern New South Wales, approximately 150,000 sq. miles, to a scale of one-quarter mile to the inch. A plotting staff of from 30 to 40 men would require at least ten years for this work. A single fast aeroplane with modern equipment, could photograph the same area at least two or three times over during the same time.

It at once follows that mapping should not be attempted unless a separate specialist organization is established for the purpose. Also that, as plotting is by far the most important item in cost, for economical work the flying should be adjusted to suit the plotting, rather than *vice versa* as is the case at present.

### Vertical or Oblique Photographs.

Air photographs are divided into two main classes—" vertical " photographs in which the camera axis is approximately vertical and the plate or film horizontal, and " oblique " photographs in which the camera axis is inclined at a considerable angle to the vertical. For plotting purposes, vertical photographs are much more convenient and oblique photographs are usually " rectified " in printing to give the equivalent of a vertical. There are also many multi-lens cameras which simultaneously expose either a vertical photograph and a group of obliques, or a group of obliques only, which are rectified in printing by special automatic apparatus to give the equivalent of a single vertical taken with an extremely wide angle lens.

The use of multi-lens cameras is only justified when they increase the effective area of country covered at each exposure, thus reducing both the amount of plotting and the flying time. Modern vertical aerial cameras, now in production both in America and England, have an angle of 45° for the limiting ray; *i.e.* 90° including angle of cone of rays. This is the maximum angle that can generally be used in the rugged country of eastern New South Wales, as the steep slopes result in obscured areas, or " dead ground " if the rays deviate further from the vertical. For the eastern part of the State, simple vertical photographs only should be used, but in the flatter western districts, serious consideration should be given to the use of multi-lens cameras. The discussion of plotting which follows assumes that vertical photographs are used. With suitable alterations it would also cover oblique and compound photographs.

### Overlaps.

Plotting of heights is carried out by stereoscopic methods. This requires that each point should appear on at least two photographs. The same requirement is necessary for fixing the position of the point in plan, as will be shown later.

Photographs are taken in parallel strips, each taken in a single line of flight as near to straight as practicable; each strip is known as a " run." Successive photographs in each run overlap and the amount of overlap is usually expressed as a percentage of the longitudinal dimension of the photograph. To secure two images of each point on successive photographs, the minimum overlap is, theoretically, 50 per cent but a larger overlap is necessary in practice. Not only must there be a margin to cover unavoidable small errors in flying and photography, but it is necessary to have a strip common to the successive overlaps in which common points can be found to carry on the plot from one overlap to the next. The overlap usually aimed at is 60 per cent. and a tolerance of from 55 per cent. to 65 per cent is allowed to cover unavoidable errors. Runs with overlaps outside these limits should be rejected for mapping purposes.

Excessive overlap is uneconomical as it increases the number of photographs required to cover a given length of run and greatly increases the cost of plotting. " Broken " overlaps, *i.e.* successive overlaps which do not have a common strip, or even overlaps not actually broken but with a strip too narrow for the satisfactory selection of common points, make plotting impossible. Runs rejected for defective longitudinal overlap must be reflown for the full length between check points; short splice runs covering gaps are quite useless for accurate plotting.

The area to be plotted is covered by a series of parallel runs of photographs. Adjacent runs must have a lateral overlap, so that common points can be selected to tie the plots together. Under present conditions about 25 per cent should be aimed at, with a tolerance of from, say, 15 per cent to 35 per cent. As with longitudinal overlaps, defective and excessive lateral overlaps are unsatisfactory and misplaced runs must be reflown.

### FLYING FOR ECONOMICAL MAPPING.

*Coverage and Scale of Photographs.*—The cost of plotting can be divided into two main items of about equal importance, viz. :—

(*a*) The cost of properly orientating and levelling each stereoscopic model formed by each pair of successive photographs.

(*b*) The cost of plotting detail from the models.

For a given map scale (*b*) is practically independent of the flying and the photography, but (*a*) is greatly affected by the quality of the flying and is directly proportional to the number of photographs. It is, therefore, most important to reduce the number of photographs to a minimum, *i.e.* to increase the area shown on each photograph to a maximum. To secure greatest coverage the widest angle lens possible should be used and the aeroplane flown at the greatest permissible height.

The limits of lens angle are set by the slopes of the country and, as previously stated, modern single lens vertical cameras attain this limit for eastern New South Wales. The usual dimensions for such cameras are about a 7-in. by 7-in. picture with a 5-in. focal length lens, giving an angle of inclination of 45° for the corner rays.

The limit of height, from the plotting point of view, is set by the scale of the map and the focal length of the camera. The scale of the negatives is the ratio of the focal length of the camera to the height of the aeroplane. By the use of enlargements it is possible to make the negatives one-half the scale of the finished map without loss of accuracy or detail. That is, if the scale of the map is to be one-quarter mile to the inch, the negatives could be taken at a scale of one-half mile to the inch. With a 5 in. focal length lens this requires a height of 2,640 by 12 by 5/12 ft., or about 13,000 ft. This is measured above the average level of the country and with country averaging say 2,000 ft. in height the aeroplane should be 15,000 above sea level.

Should a smaller scale be adopted, should a larger camera become available, or should better photographic technique increase the permissible enlargement of negatives (the last is very probable), the height should be increased correspondingly. At present, flying companies are averse to flying above about 13,000 ft. as oxygen and other special expensive equipment, and high performance aircraft are needed for great heights. This objection is justified for the class and amount of work now offering, but should a large-scale mapping project be undertaken, the flying height should be increased to the maximum permissible for the plotting scale, if it is within the " ceiling " of any aeroplane available. The extra cost of high flying will be small in comparison with the enormous savings in the cost of plotting.

*Accurate Flying.*—If it were possible to take all photographs at the same height, with the camera axis truly vertical at each exposure, plotting would be cheap and easy. The main obstacle to plotting is the determination of and corrections for the unavoidable tilts of the camera. Under the most favourable conditions this work represents half the cost of plotting. Where it is necessary to apply corrections to observations, the smaller the corrections, the easier is the work and the more accurate is the result. Any reductions in tilt will therefore pay handsome, even if invisible, dividends in the reduction of cost of plotting. Also the less the aeroplane deviates from a straight line during flight, the simpler are the necessary computations.

For this reason " automatic pilots " and other aids to accurate flying should be used. They are universally used in England and are rapidly being adopted by other countries. It has been found possible, with such aids, to limit the tilts to one-half degree. With ordinary manual control, even by an experienced pilot, tilts run up to about two and one-half degrees. In this connection it might be observed that both a natural aptitude and a long term of training and experience are necessary before a pilot can keep tilts even within this limit. By the full use of flying aids, moreover, it is possible greatly to reduce the deviations of the aircraft from the straight line.

The great savings in plotting costs resulting from the improvements in the accuracy of flying far outweigh the additional cost of flying aids. The importance of this aspect cannot be over-emphasized.

## Auxiliary Instrumental Records.

On the margin of each aerial photograph is photographed a serial number for identification and the readings of certain auxiliary instruments. In some cases the instrument records are photographed on a separate small film synchronized with the aerial camera. The purpose of these records is to aid in the subsequent plotting and they should be considered solely from this viewpoint.

*Height by Altimeter.*—The height, by altimeter, is the most important record taken and should always be recorded. What is required is the difference in height between each successive exposure, not the actual height above sea level. This is frequently misunderstood by those responsible for the photography and often unsuitable altimeters are fitted.

A small error in the determination of the height of the aircraft by altimeter is unavoidable, even with the greatest care in taking air temperatures during the ascent and descent. A consistent small error in the height is unimportant as it produces merely an overall change in horizontal and vertical scales of the same proportion and can very simply be corrected in adjusting the plan to ground control. The calculation of flying height by this method is easier and more accurate than from altimeter and temperature readings.

Small differences in the flying height between successive exposures are, however, most important. They do not affect the plan plotting, but produce equal and opposite differences in the apparent level of the ground as determined by stereoscopic observations. It is true that the height differences can, in theory, be computed from measurements made on the photographs but this is a very long and laborious method.

What should be recorded on the photographs is the readings of a differential altimeter with an open scale extending only, say, 100 ft. each side of the zero so that it can be read to a few feet. This is set at zero, on each flight, when the aeroplane reaches photographic height and then records the rise and fall of the aeroplane. These differential readings are very accurate if the air pressure and temperature at flying height are observed and are exactly what is required for plotting. The best instrument so far produced is the so-called "Statoscope," a simple "U" tube water manometer with one end exposed to the air and the other end subjected to constant pressure set to equal the external air pressure at the start of the flight. This instrument requires a separate photographic record.

*Level Bubble, Horizon Image, etc.*—Attempts have been made to determine tilts at exposure by means of a level bubble, horizon image and other similar accessories. If a successful method could be developed most of the difficulties attending plotting would be overcome. Unfortunately, the level bubble fails owing to the unavoidable random accelerations of the aeroplane, which affect the apparent direction of gravity, while the horizon is only useful in very flat country with a clear atmosphere. Under the conditions met with in eastern New South Wales, neither is of any value.

*Compass Bearing.*—A compass bearing reading also fails owing to the stray magnetic and electrical fields associated with the aeroplane and camera, the latter being, normally, electrically operated. It is also unnecessary as the methods of plan plotting do not require this azimuth tie.

*Time.*—Usually a watch or clock with a second hand is photographed. Strictly speaking, this is not a plotting aid but is a most valuable check on the operation of the camera (which for best results should be automatic and set for a constant time interval on each run).

*Temperature and Altimeter.*—As has been already explained, only the differential heights are required. For their computation from the instrumental records, the temperature and pressure of the outside air should be known. The former should be observed by means of some form of remote reading thermometer, while the latter is readily deduced from the reading of the aeroplane's altimeter. These readings need not be taken with each photograph but should be noted at intervals during the flight.

## Planimetry.

The plotting of plan positions without determination of levels is a relatively straightforward task. It is very simple in theory although, of course, a great deal of extremely accurate detail drafting is required for its execution. It is usually known as "planimetry" and requires no special apparatus other than a simple stereoscope to assist in the examination of the photographs and identification of features and land forms.

It may be carried out with anaglyph projectors or automatic plotting machines but the use of such expensive apparatus on such simple work is probably unwarranted; they should be reserved for the more difficult work of levelling and contouring.

The method used is variously known as the "Radial Line," "Arundel," or "Minor Control" method. It is based on the fact that if tilts are met they have only a second order effect on the bearings of images from the principal point of the photograph, while height differences only produce radial displacement of images. Consequently, each photograph can be treated as a plane-table sheet, with the table set up at the principal point. No notice is taken of other than the bearing of each image from the principal point. The distances between images are ignored, as are also the bearings of other joining lines. The successive photographs in each run are tied together by intersection and resection and any points required for plotting are located by intersection. All this work is very similar to a plane table survey, the principal points of the photographs being equivalent to "occupied stations." The details can be found in any recognized textbook on aerial survey.

One great advance has recently been made in this work, viz., the excellent and simple mechanical device known as a slotted template, patented by the Fairchild Company (U.S.A.). The method adopted for the use of this instrument is based on identical principles, except that in lieu of hand plotting each photograph is replaced by a template with a hole drilled at the principal point and radial slots cut in the direction of each ray used in plotting. Pins are placed through the appropriate holes and slots to join the templates together and the assembly mechanically and quite automatically assumes the form of the completed plot. The pins are drilled so that the points so located are readily pricked through on the plotting sheet.

## Determination of Heights.

The determination of relative heights on a stereoscopic pair of photographs, by parallax measurements, would be a relatively simple matter if the photographs were taken from the same height without tilt. All that is required is the height of the aeroplane above the datum point and the "air base" or distance between the two points from which the photographs were taken. The former can readily be determined from photographic scale or by corrected altimeter readings and the latter can be determined, with ample accuracy, from the overall length of the line of flight between check points. As the aeroplane is flying at great heights where the air is little disturbed, it travels at practically constant speed and as the camera is automatically operated at equal time intervals, all air bases will be practically equal. The errors in this assumption are negligible.

The differences in height of the aeroplane can be determined by "statoscope" or similar records and the necessary corrections made. There remain the errors due to tilt, and this is the major problem of aerial survey.

*Corrections by Ground Levelling.*—The methods mainly used to date depend on correcting tilt by the determination of levels on the ground. In some so-called aerial surveys all necessary levels for plotting have been obtained by ground methods, the photographs only being used for planimetry and to assist in sketching the shape of the contours.

It is not necessary to proceed to this extreme but the methods most used depend on the determination, on the ground, of sufficient levels in each overlap to correct each stereoscopic pair for tilt. When this is done it is not usual to compute tilts; where parallax measurements are made for hand plotting, sufficient points are levelled to enable tilt corrections to be interpolated between control points; where automatic machines or anaglyph projectors are used, the photographs are set to eliminate the differences in height and the tilts are thus automatically corrected.

The reasonable simplicity of the office work and the fact that most aerial survey has been carried out in settled overseas countries, where many levels have already been determined, or, at any rate, access for levelling is simple. The necessity for fairly close spaced levels (not more than 1 mile apart in each direction is normal) makes these methods unsuitable for the wild and inaccessible areas it is desired to survey in eastern New South Wales.

*Correspondence.*—There is only one method that eliminates the necessity for closely spaced ground levels and enables aerial photographs to be used for "bridging" between widely spaced ground control. This method is known as "correspondence" and is due to Fourcade. Its discovery was probably the greatest forward step ever made in aerial survey.

The principle is simple but is rather difficult to grasp. Suppose two photographs to be exposed exactly in one common plane, with principal points $P$ and $Q$ respectively. Let the point $P$ on the first photograph appear as $P^1$ on the second and the point $Q$ on the second photograph as $Q^1$ on the first. Join $PQ^1$ and $QP^1$ on the respective photographs. Also let any other point $A$ have images on both photographs. If an elevation is taken on a plane at right angles to the line of flight, it is at once evident that the two images of $A$ on the separate photographs are at the same distance from the lines $PQ^1$ and $QP^1$ respectively. When this condition exists (*i.e.* when the two images are equi-distant from the line of principal points) the images of the point are said to be in correspondence.

It can be shown that correspondence can only exist over the whole overlap when the photographs are co-planar; as soon as tilts exist correspondence errors are introduced, varying in sign and amount with the amount and direction of tilt and the position on the overlap. By measurement of the correspondence errors the relative tilts of any two photographs can be deduced. Alternatively the photographs can be mounted in special carriers which are tilted till all correspondence errors are eliminated. Then the relative tilts of the two carriers will equal the relative tilts of the camera at exposure. This makes it possible to compute the "air traverse," *i.e.*, the positions of the lines joining successive points from which photographs are taken, thus bridging between ground control, and then to determine the tilts of the various photographs.

Correspondence measurements are rapidly and accurately made by a method very similar to the well-known parallax method, provided the floating mark used is suitable for the work and proper movements are provided. The computations necessary are rather formidable and rapidly become more difficult with increasing tilts.

*Plotting Devices.*—Many types of apparatus have been developed to assist in the plotting. The simplest is the ordinary stereoscope with parallax measuring device for determination of apparent heights. This has no provision for measurement of tilts, which must be determined by one of the methods just outlined.

A similar apparatus equipped with a device for accurately measuring correspondence errors, enables tilts to be computed by the correspondence method. A very suitable apparatus of this type is the Cambridge Stereo-comparator. Alternatively "compound stereoscopes," as they are called, in which the photographs are tilted to eliminate correspondence errors and thus determine relative tilts directly, are available. Both of these aids are suitable for bridging between ground control. The former is simpler and more robust. It is naturally cheaper and much less likely to require adjustment. The computations are easier with the second, however, but this advantage is not very great with a high standard of flying. If tilts can be held within small limits and reasonably straight courses flown, the stereo-comparator is probably better, otherwise compound stereoscopes should be used.

Another type of apparatus is the "anaglyph" projector. Special reduced transparent positive prints are made and placed in projection lanterns and enlarged pictures projected on a horizontal board. To obtain stereoscopic effects one photo of a stereoscopic pair is illuminated by red light and the other with green. The observer wears glasses having one red and one green lens. The plotting is carried out on the horizontal board, using special markers of adjustable height, set to correspond in height with the apparent height of the anaglyph model. Thus if the photographs are properly adjusted to compensate for tilts, the plan can be plotted and heights determined at one setting. While only one pair of photographs can be observed at a time, a number of projectors can be set up to reproduce a run of photographs and each consecutive pair illuminated in turn, to plot the complete run on one sheet.

The anaglyph is an old device but cannot be recommended, although it is still widely used, especially in the United States of America and Canada. It is not adapted to correspondence settings, particularly in un-settled country where there are usually no sharply defined features such as houses and roads, and hence is not suitable for bridging. It is only adapted to the system of tilt correction by ground levels on each overlap. Even in these conditions experience seems to show that it is uneconomical, as compared with either of the other two main methods—radial line plotting for planimetry with computation of levels for parallax methods, or automatic plotting machine.

The last, and most advertised type of apparatus, is the so-called automatic plotting machine. This type of apparatus is made in many different forms and in many countries and the general principle is the same throughout. The machines are not automatic in the ordinary sense of the word, as a trained observer must operate them and direct the plotting. They consist of a compound stereoscope and a plotting mechanism. A floating mark is moved by the observer over the stereoscopic model seen in the stereoscope, tracing any natural feature or contour line he desires to plot. The plotting mechanism is connected to the floating mark so that its movements are reproduced on a drawing sheet.

The machines were mostly designed for work in settled country with some known levels and sharp man-made features for correspondence setting when this is required. A number of them are unsuitable for bridging in unsettled country, having unsuitable movements for easy correspondence settings, but some could be used. These machines are most expensive, however, and it is not economical to use them for bridging where the much cheaper and simpler compound stereoscope or stereo-comparator will serve equally well. For planimetry they are also probably uneconomical, as their cost is so high and they do not show any marked advantage in speed over the simple radial line method. They are, probably, the most economical method of contouring, but, owing to their overhead charges, only if they can be kept in constant use. When used, care must be taken to see that the camera used for the photography is matched to the plotting machine.

## Ground Control.

In mapping any area, no matter how small, by aerial survey methods, ground control is essential to establish a base for scale, azimuth, and level. Also, if the survey extends over a large area, a triangulation and level control must be established over the whole area, just as in ground methods, so that plots of adjacent sections can be properly adjusted to form the full map. To fulfil the former purpose efficiently, care must be taken in selecting the ground points. To achieve this the ground control should not be undertaken till the flying is completed; this also avoids the possibility of obtaining ground control that cannot be identified on the photographs.

In settled country or country easy of access ground control, especially for level, may be closely spaced to avoid bridging. The control points should be well distributed over each overlap and are more efficient when placed in the strips common to adjacent overlaps. In rugged inaccessible country, such as the greater part of eastern New South Wales, ground control would, for economy, be as widely spaced as is practicable and bridging would be resorted to. The aerial survey is made in a series of parallel runs covering the whole area, with tie runs, approximately at right angles thereto, at intervals. Although it is not absolutely essential, the plotting is very much simpler if the ground control points are within the tie runs and they should be so situated if reasonably possible. The tie run positions should be selected to include, as far as possible, points suitable for ground control. If required they can be slightly skewed for this purpose. They can also be flown in sections, each section extending from one control point to another, making an angle with the adjacent sections.

Where bridging is undertaken, the maximum spacing of ground control points in each tie run is dependent on the coverage of the photographs. It is governed more by the number of photographs between tie points than by the actual distance, but the limitation of intervisibility of stations may limit the spacing when small plotting scales are used. For the figures previously taken as a basis (*i.e.*, plotting scale one-quarter mile to the inch, photo scale one-half mile to the inch, 7 in. by 7 in. camera, 5 in. focal length lens) the maximum spacing for plotting purposes is about ten miles. The maximum distance between tie runs is the same as the maximum spacing between control points in each run.

## Organization.

The work of aerial survey and mapping requires much diverse work of a very specialized nature. Specially trained aviators and photographers are necessary for the flying. Highly skilled photographic technicians, and a survey organization for ground control, etc., are also required, but by far the greatest amount of specialized work is found in the drawing office.

Parallax and correspondence observation is especially important, a natural aptitude, particularly excellent eyesight, constant practice and many months' regular training are essential to produce a good observer. If the observer should leave this work for a considerable period he requires retraining before he can again perform it satisfactorily. Other important specialized works are the marking of common points for radial line planimetry, which also requires much practice, the radial line plot itself, if the slotted template method is not used, the computation of tilts and air base traverses from correspondence measurements, etc.

Aerial survey should not be undertaken piecemeal or in small sections, otherwise a great deal of money will be wasted. It can only be efficiently carried out by a large organization of specialists trained for their work. If such a survey is undertaken a programme of work should be established, the necessary equipment obtained and the staff selected and trained. The amount of equipment and size of staff will, of course, depend on the extent of the work to be undertaken and the time allowed for completion.

The following are considered to be the main lines on which such an organization should work, in mapping country containing large unsettled areas which are difficult of access for close spaced ground control.

(1) The best available type of camera selected to suit the plotting scale, the nature of the country to be mapped, and the plotting equipment, should be purchased by the organization. Should the work be large enough to employ an aeroplane full time for a considerable period, the organization should operate its own aeroplane, otherwise the flying should be carried out by contract, the camera being loaned to the contractor. In either case only the highest possible standard of flying and photography should be accepted.

(2) The necessary ground control should be carried out by the organization's own staff.

(3) Planimetry should be carried out by the radial line method, preferably using slotted templates if rights can be secured.

(4) Bridging between widely spaced ground control should be generally used, but in some areas close level control may be available for simpler methods.

(5) Bridging should be based on correspondence observations by stereocomparator and computation.

(6) Levelling and contouring should be carried out, either by parallax measurements in a simple stereoscope with computed tilt corrections, or by an automatic plotting machine. The decision would depend on whether the rate and quantity of work to be undertaken would repay the high cost of the machine.

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## *SOUTH AFRICA'S WAR EFFORT.*

(Reprinted by permission from *The Engineer* of 26th December, 1941. Contributed by their South African Correspondent.)

Two years of war activity have driven South Africa's industrial advancement far ahead of the position it would have reached under normal peacetime conditions. The country is now able to supply not only its own Army with all it needs, but it is able to ship to the Allied Armies in the North and Middle East great quantities and varieties of manufactures and spares.

When South Africa faced the urgent need for reorganizing her industries to achieve the greatest possible output in the shortest time when war broke out, it was common knowledge that the military supplies cupboard was bare. There were no reserve stocks of uniforms or equipment nor, indeed, any prepared plan for obtaining them. In the munitions and armament field a little work had been done in the production of field mortars, one experimental howitzer had been constructed and there was a plant—that of the Royal Mint on the Rand—capable of producing 10,000,000 rounds of 0.303 rifle ammunition per annum.

To-day a large mechanized army has been placed in the field and supplied through a fast and vigorous campaign. South African made guns are flowing off a production line which was not even on paper about fifteen months ago. Tens of thousands of bombs have been produced and shells, grenades and many other types of munitions.

The South African boot and shoe industry was speedily called upon, for the Army had to be quickly shod. Actually the capacity of the industry in machines and operatives was far in excess of the Army's demands, but it consisted of separate units, which knew little of co-operative effort. When particulars of these requirements were furnished, the Army boot specification was drawn up and a South African type evolved, and very soon the factories were delivering the goods by the thousand. They caught up with the demand, then exceeded it, and finally were able to accept large orders for other units of the Allied Armies. At present they are engaged on orders for hundreds of thousands of pairs. The total annual production of all kinds of footwear in South Africa is now between 7,000,000 and 8,000,000 pairs.

Blankets were another urgent need of the growing Army. South African wool went into the looms and the flow began. A high standard is demanded, and South Africa has reaped the benefit of its early war production experience by being called on to fill large orders for the Middle East. The call for uniforms for the tens of thousands of men who joined up gave the clothing industry also a chance to demonstrate its ability to drop speedily into mass production, not of one type of military dress only, but of a surprisingly large variety. South Africa has no mills from which to draw stocks of cloth, but already one for the manufacturing of khaki drill has been set up and may lead the way along a new avenue of industrial development. Young and as yet small industries in an associated field have also been given a chance. Canvas and webbing are now woven in great quantities, and leather goods, which previously were all imported, are now coming from South African benches.

## Canned Food for the Troops.

Even in the days before the war the South African food canning industry, fairly well-established and organized, was well on the upgrade, and the war immensely stimulated the demand, increasing the call for existing lines as well as encouraging the development of new types. Among new products not previously canned in the Union on a commercial scale is the important Army meat and vegetable ration. Certain canneries in the Union are specializing in this production, which consists of meat, peas, carrots, beans and onions, all in one can. Other canneries are specializing in the production of mixed vegetables, and the result compares favourably with anything produced in the world to-day. A tin of mixed vegetables may contain potatoes, carrots, peas and beans, with turnips, onions and celery used as flavouring. Sweet corn is also being canned on the Rand in considerable quantities. Sausages, too, are being canned for the Defence Force in quantities which before the war would have seemed enormous. Even dried fruits are now being put up in cans, the chief lines being prunes, raisins and apricots. The canning of butter and wholesome pasteurised cheese for the troops is also being undertaken with great success by various creameries in the Free State, Natal, East Griqualand and the Cape Province. Alongside this important development, large quantities of fruit and jam—plum, peach, fig, apricot, pineapple, and gooseberry—are being canned, not only for home consumption, but also for South African troops and for export to the United Kingdom.

Full utilization of the food resources of the sea have never previously been attempted by the Union, but now the resources of the fish canning industry in the Union have been drawn upon very heavily to supply defence requirements.

Each small tin—whether its contents be fish paste, balls, cakes or flakes, or fried fish in mustard sauce—represents an easily transported, always safe and appetising quantity of food which adds both nutrition value and palate appeal to the ordinary rations issue.

The Department of Defence has also decided that canned snoek, canned pilchards and canned mackerel will be admirable for the Union troops. This will be the first attempt to can any of these fish on a large scale. Before the war large quantities of crayfish were canned and exported mainly to France, but France collapsed and now Great Britain is buying virtually the whole of the South African crayfish pack.

### ENGINEERING RESOURCES.

But it may confidently be said that in the engineering field South Africa has received the greatest benefit from the war. South Africa has one major asset, the value of which cannot be overstated—its established steel works. When the Great War was waged twenty-five years ago they did not exist; to-day they are producing over 400,000 tons of steel annually, and are still being expanded. Without them South Africa's munitions and armaments production would have been a mere trickle. With the steel available it was possible to take advantage of the existing engineering resources of the country. These were not, however, production resources in the true sense, inasmuch as they consisted of the repair and maintenance shops of the railways and municipalities and the engineering shops which have grown up around the mining industry, as well, of course, as the marine engineering shops at the coastal towns. The latter, however, are playing a very important part in their own sphere and have been too busy on the repairing of damaged ships to enter into the munitions and armaments programme. Moreover, war conditions demanded deliveries in vast quantities, and the immediate problem was to adapt the existing plants to the new needs of mass production.

In this respect the difficulties went deep indeed, but first showed themselves in the lack of machine tools and skilled workers. The former position is improving as the result of importations, and also by reason of ingenious adaptations of machines and even the manufacture in considerable quantities of single-purpose lathes in this country. The lack of skilled men, however, is still very much felt and has been complicated by the need for skilled artisans in the Technical Services and the Air Force. Nevertheless, the engineering industry has forged ahead and production has increased to a *tempo* which would have been thought impossible two years ago.

### GUN PRODUCTION.

There are many specialized developments aimed essentially at war production, but these nevertheless will have a far more lasting benefit than merely meeting a transitory demand. One is gun production. This has called not only for an elaborate equipment of machinery, but for special steels, for highly skilled precision work and the building up of a central assembly factory. The steel works met the call for the new steel and after research built a heat treatment plant—ovens, quenching pits, etc.—and had it in operation in six weeks. The production of the component parts of the gun has been spread out over a large number of workshops, and thus the experience gained is not confined to any one branch of the industry nor to any one centre. Wherever suitable workshops existed or could be built up from machines already available, there the work has been sent. The components flow to one central ordnance factory, where the major work on the barrels is done. There the assembly takes place, and there, too, are manufactured the sights for the guns. On the "repetition tasks" women are proving excellent workers and a large staff of skilled machinists is benefiting from intensive training and experience in the work.

### Shell Production.

Shell manufacture demands mass production. At first plant could not be imported from overseas, except at great expense of time, and so it was decided to build it in South Africa. Bigger castings than had ever been made in the country were successfully turned out and on the scheduled day the plant went into action. Its output has steadily risen and a "bottle neck" in finishing the shell bodies has been overcome by the production in the country of large quantities of single-purpose lathes, most of which are operated by women.

### Armoured Cars and Vehicles.

One of the greatest achievements has been the mass production of armoured cars and vehicles for the mechanized army. The motor-car industry, which has its headquarters at Port Elizabeth, is now ranked as the Union's most important industry. Certainly its most outstanding achievement, in co-operation with the country's leading engineers and technicians, has been the production of great quantities of armoured cars. The only imported parts of the cars are the chassis and engine. The framing, plating, turret building and final equipping of the car is entirely from South African resources, and a first-class job has resulted, one which has earned the praise of the Imperial Army commanders in the East African campaign.

### Mechanizing the Armies.

But a far more extensive production programme was called for in the mechanization of the Army. No fewer than sixty-five types of vehicles are demanded, some in relatively small numbers, but others in great quantity. Once again the work was spread over the workshops of the country, and on the chassis that came from overseas were built a great variety of bodies—for troop carriers, mobile workshops, staff cars, light aid vans, radio vans, ambulances, oil tanks to supply other vehicles with petrol and oils, large trucks for the engineers, road construction trucks, scores of specially fitted ambulances, special trucks to carry artillery units and ammunition, besides other models used to carry out the various duties a modern army is called on to perform. Provision has been made for every conceivable contingency in motor transport.

One of the "high lights" of munitions production in South Africa is the manufacture of howitzer guns. On February 16th, 1941, the first battery of howitzer guns to be manufactured in South Africa was officially handed over to the Defence Department. Every component of the guns had been produced in South Africa, including the sights. Yet on June 1st, 1940, there was not a machine tool in the Central Ordnance Factory, where these guns are now being turned out on mass production lines. It has been stated that this is probably the first time in history that the mass production stage of a new gun has been reached in nine months. Again heavy firing power combined with portability render field mortars a type of artillery specially suitable for African conditions and these weapons are being produced in great quantities. Very special problems were presented in the design and manufacture of the sights, both on account of the fine limits of accuracy required and of the large numbers of small and intricate components. Nevertheless, a Transvaal concern, specializing in high-precision work is producing sights which, it is believed, contain various improvements not yet adopted by munitions factories overseas. So good is the job that the British Government has placed with South Africa a large order for these sights. South African firms are manufacturing field mortar bombs by processes which they have evolved themselves with no advice from overseas experts and with no details of the processes used in British or American factories to guide them. Almost from the very beginning of the war the production of heavy aircraft bombs has been in full swing.

From the long list of articles now being made for use on the war fronts may be mentioned at random hand grenades, Bellman hangars, portable bridges, gun aiming posts, air raid sirens, steam-heated cooking troughs and water carriers.

### SHADOW FACTORIES.

To appreciate the extent to which the Union's engineering industry as a whole is collaborating in the production of munitions it has to be realized that such articles as howitzers or armoured cars or to a lesser extent bombs, shells and depth charges contain many components and these are produced in "shadow factories" throughout the country. For example, the number of workshops which have collaborated in the production of the bombs dropped by airmen on Tripoli and Benghazi is considerable. Other firms have co-operated by manufacturing jigs, tools, gauges or machines for munitions production. Thus one Rand concern has built, *inter alia*, a bullet piercing and a bullet assembly machine, while another has made a number of lathes and is producing machines of various types for foundry work. A firm of specialists has designed and made special machines to produce small springs and spring washers, required in large quantities by the Director-General of War Supplies.

All the switchgear for the shell plant was made in South Africa from imported components, while several of the transformers were also locally manufactured. Among other products of electrical engineering workshops are spot welders, arc welders, D.C. generators, induction motors, and oil-cooled metal-clad reactors for arc furnace control.

In conclusion, it may be asserted confidently that the biggest factor in enabling the secondary industries in South Africa to expand rapidly and meet the heavy demands, not only to increase production, but to cope successfully with the calls for entirely new manufactures, has been the efficient generation and the economical distribution and utilization of electric power.

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## *THE USE OF BALLOONS IN WAR*, 1784-1902.

*By* COLONEL SIR CHARLES ARDEN-CLOSE, K.B.E., C.B., C.M.G., F.R.S.

THE coming of the aeroplane very soon rendered the balloon obsolete for military use, except for one special purpose. But, until this happened, the balloon had a value, in certain circumstances, although it never fully realized the hopes which were entertained of it in early days. It is true that its usefulness was restricted, and that the great masters of the art of war thought little of it. But during the hundred and twenty years from the date of its invention in France, in 1783, until the conclusion of the war in South Africa, in 1902, there were many occasions on which the use of balloons in war was justified, and it may be instructive to consider some of these occasions in the French Revolutionary Wars, the American Civil War, and in some British campaigns.

The story has often been told how the brothers Montgolfier sent up the first fire-balloon, at Annonay, near Lyons, on the 5th June, 1783, and how the French physicist, Charles, made an important advance by using hydrogen to inflate the balloon. In the same year Benjamin Franklin wrote to Sir Joseph Banks, President of the Royal Society, that amongst the uses to which a balloon might be put were the "elevating an engineer to take a view of an enemy's army, works, etc., conveying intelligence into or out of a besieged town, giving signals to distant places, or the like." *

Mr. I. B. Cohen in his article in the *Journal of the Franklin Institute*, remarks, that "All of the modern features of the hydrogen balloon are due to Charles's invention." We may note how quickly things moved in France; the use of hydrogen, the material of the balloon, the use of a net from which to suspend the car, the car, the valve, the grapnel, the use of sand as ballast, all seem to have come into use during the first few months after June, 1783. Franklin remarked that, "By the emulation between the two parties running high, the improvement in the construction and management of the balloons has already made a rapid progress." * The "two parties" were, of course, those who pinned their faith to the hot-air balloon, and those who were in favour of the use of hydrogen.

Franklin, writing on 16th January, 1784, made a rather remarkable suggestion. He said, "Five thousand Balloons, capable of raising two men each, could not cost more than Five ships of the Line; and where is the Prince who can afford so to cover his Country with Troops for its Defense, as that Ten Thousand Men descending from the Clouds might not in many places do an infinite deal of mischief, before a Force could be brought together to repel them?" *

Shortly after the beginning of the French Revolution a school of army ballooning was established at Meudon and four balloons were made and sent to each of the four revolutionary armies in the field.

*Fleurus*, 26th June, 1794. The first time that balloons were actually employed in military operations in the field was at the Battle of Fleurus (about 5 miles north-east of Charleroi), between Jourdan's army of *sans-culottes* some 73,000 strong, and Coburg's Austrians numbering about 52,000. It is recorded that, before the battle, Colonel Coutelle and General Morlot made two reconnaissance ascents, lasting four hours each. It has even been stated that the French victory was due, in large measure, to the knowledge thus gained of the enemy's dispositions. However that may be, it seems to have been recognized that a balloon might be a useful adjunct to the normal intelligence apparatus, and "the balloon corps was, thereafter, in continual demand for the rest of the campaign." Another account says that the information which Coutelle "signalled to Jourdan proved to be a material factor in the far-reaching victory which the French forces gained over the Allies, and the achievement was repeated in the subsequent battle on the Ourthe, near Liège." Yet another account has it that "At Maubeuge, Charleroi, and Fleurus, balloons with their attendant equipment of men and *matériel* accompanied the French forces. At the latter battle the height of 1,300 feet was attained, and the results were at the time reported to be very satisfactory." Whitworth Porter quotes Dr. Mier's Journal, "J'ai vu à Paris et à Meudon le Capitaine Coutelle, le même qui le 17 Juin, 1794, montoit le ballon qui dirigeoit la merveilleuse et importante reconnoissance de l'armée ennemie à la bataille de Fleurus accompagné d'un Adjutant Général . . . Coutelle correspondit avec le Général Jourdan, Commandant de l'armée Française par les signaux de pavillon convenus." He goes on to say, "Jomini thinks that the results obtained by the French in these operations were not worth much, and that they must have been grossly exaggerated at the time."†

It is interesting to note that in spite of this fairly favourable beginning of reconnaissance by balloon, Napoleon thought little of this method of obtaining information. The Balloon School at Meudon was finally closed in 1802, and there

* *Journal of the Franklin Institute*. August, 1941. Article by I. Bernard Cohen. "Benjamin Franklin and Aeronautics."

† *History of the Corps of Royal Engineers*. By Whitworth Porter. Vol. II, page 189.

was no more military ballooning in France for many years. It may be supposed that it was considered that the information received was not worth the transport involved. Otherwise the conditions of war at that time were favourable to the use of balloons; the distances were small; the troops displayed in masses; and the artillery had but limited range. Those who have had some experience in the art of observing from balloons will realize that one of the difficulties is the small inclination of the angle of vision at ordinary ranges. Thus, if the balloon is a thousand feet above a plain and the enemy's units are, say three miles off, the angle of slope is only some 3 or 4 degrees. But things were somewhat different in 1794.

Other instances of the use of balloons by the French army are relatively few, and need only a brief description.

*Algeria*, 1830. In this campaign a professional aeronaut was employed, who made one ascent and received a "citation of praise" from the military command. Apparently the information received was of little or no value.

*Italian Campaign*, 1859. In this French campaign against Austria some montgolfiers were used by the civilian aeronauts, the brothers Godard. The French authorities were not satisfied with the results but the aeronauts "stressed the moral effect on the French troops." The moral effect on the Austrian troops is not indicated.

*Franco-Prussian War*, 1870-71. It is very well known that, during the siege of Paris, balloons were the only means by which the besieged city was able to communicate with the rest of the country. No fewer than 64 balloons were sent up from Paris during the siege. Of these a certain number were shot down by the enemy; two were never heard of again, and probably were carried out to sea; but the majority got safely away. They carried pigeons so that messages could be replied to. The organization was in the hands of the Post Office and the personnel was mainly supplied by the French navy. On the 7th October, 1871, Leon Gambetta escaped from Paris in a balloon, "thereby undoubtedly prolonging the war."*

*Tongking*, 1884-5. The French used balloons during this campaign. It is not known whether they were of any value.

From the above short account of the actual use made of balloons by the French, in the various wars and campaigns conducted by them, it will be seen that, though the invention was a French one, and though the French had every goodwill towards such an invention, they found that, in practice, its actual value in war was small. But the French authorities ultimately re-established the balloon school at Chalais-Meudon, and in the eighties of the last century that school was the principal centre of military ballooning in the world. The time was then passing for the effective use of balloons; we have only the uncertain record of French ballooning in Tongking. In the eighties Otto Lilienthal was practising his gliding flights, and it is noteworthy that he expressed the view that the balloon had actually been an obstacle to the development of flight.†

*The American Civil War of* 1861-65. There is a more satisfactory tale to tell of military ballooning in the United States. It may be said that there were a few occasions, during the early period of the war, when balloons proved to be of some real value. Those who desire to study this matter in detail will find much hitherto unavailable information in a recently published book, *Aeronautics in the Union and Confederate Armies*.‡ It appears that the military use of balloons was unknown until the outbreak of the Civil War, although there had been, for many years previously, considerable progress in civil ballooning, which, in

* *Journal of the Franklin Institute*. August, 1941, page 118.

† *The History of Aeronautics in Great Britain*. By J. E. Hodgson. Oxford University Press, 1924, page 276.

‡ By F. Stansbury Haydon. The Johns Hopkins Press, 1941.

fact, rendered possible the employment of balloons in the war. Balloon voyages were common in America in the middle of the nineteenth century, and ascents and flights were a not infrequent accompaniment of festivals and country fairs. The best known balloon voyage was that of Wise, La Mountain and Gager, who covered eleven hundred miles in twenty hours, in 1859, from St. Louis to Henderson, New York.

All the ballooning carried out during the Civil War was the work of well-known civilian aeronauts, who never received any military rank or position. The book mentioned above describes in great detail the services of the most noteworthy of these aeronauts, James Allen, John Wise, John La Mountain, and, above all, T. S. C. Lowe. Allen was the first to be employed with the Federal troops; he had been a soldier in the Marine Corps of Artillery before the war, and offered his services as a balloonist. In July, 1861, he is found near Washington, ascending to 500 feet in a half-filled balloon, but it was a windy day and observation was difficult. There was no properly organized system for the supply of hydrogen; there were no trained assistants. "It may be said . . . that Allen himself did not fail. His apparatus, not designed for the use imposed upon it, coupled with the lack of trained assistants to handle it, failed."

Next we come to John Wise, "a veteran Pennsylvania aeronaut." He was responsible for the first balloon in the United States which was designed for military use. Wise managed to get his balloon near the battlefield of Bull Run, 21st July, 1861. Owing to the unwise interference of the Chief Signal Officer, the balloon was tied to a wagon and got wedged in a wood; the horses were driven ahead and rents were torn in the balloon, so that no use could be made of it. And thus ended the second effort, and the Topographical Engineers reported unfavourably on Wise and his apparatus. But it would appear that he was not to blame.

The next aeronaut to take a prominent part as a balloonist in the Civil War was John La Mountain, who had been with Wise in the great flight from St. Louis. He offered his services to the Federal Government, but the Secretary of War was not interested and did not answer his letters. However, his services were eventually accepted by General Butler for use at Fortress Monroe. La Mountain made an ascent at Hampton on 25th July, 1861, but the wind prevented any great height being attained. But on the 31st he went up again, got to a height of 1,400 feet, and was able to detect Confederate positions and movements within a range of some thirty miles, "the first effective use of observation balloons in the American army." "In general, the information obtained in the July 31 ascension was such as to give Butler a greater sense of security."

Later he served with success in the Army of the Potomac, until February, 1862. He had the interesting experience of undertaking free runs over the enemy's territory, making use of a high return current. The information that he obtained on 10th December, 1861, was of value. "The main body of Johnston's army was seen to be concentrated still at Manassas and Centreville, with a very noticeable increase in field works between Manassas and Fairfax Court House." Unfortunately, La Mountain and Lowe could not manage to get on with each other, and as a result of their quarrel the former was summarily dismissed in February, 1862.

A large section of the book mentioned is devoted to an account of T. S. C. Lowe and his work for the Federal army. After La Mountain's dismissal, Lowe became the "undisputed master of balloon operations." He had had a few years of experience in the building and operating of civil balloons for exhibition purposes, and it may be said that his is the outstanding figure in the history of ballooning in the Civil War. He had much pertinacity—and needed it. Mr. Haydon gives us an interesting story of Lowe's interview with President Lincoln, who took him to see General Scott, who approved of the use of Lowe and his balloon. But Lowe's troubles were by no means over, and it was not until August, 1861, that orders were issued for the construction of a new balloon with the necessary accessories. The construction was under the supervision of the Topographical Bureau, and so also were the operations.

There was much red tape in the matter of the provision of a detachment for working the balloon. A ground crew might be trained and taken away when they had learnt their work. No permanent crew was ever allotted.

On the 29th August, 1861, Lowe made an ascent from the neighbourhood of Arlington, and saw entrenchments being made by the enemy and guns in position. From time to time he went up, and it is stated that his reports were reasonably accurate. Observation, not fire direction, was his main function, and his constant vigilance provided some security against unexpected attack. General McClellan made an ascent with Lowe on 7th September and spent two hours in observing the enemy's positions. After this McClellan recommended the manufacture of four more balloons.*

The volume of these balloons varied from 15,000 to 32,000 cubic feet. The control cables varied in length up to 5,000 feet. There was a mobile field generator for the production of hydrogen; each generator was drawn by a team of four horses. "The satisfactory mobility of the generator was proved successfully in several major campaigns" in the Peninsula, Fredericksburg, West Virginia, after Antietam, and in the Chancellorsville campaign.

The first steps towards the establishment of a balloon corps were taken in September, 1861, and various civilian aeronauts were engaged, but none, from Lowe downwards, had any military status and, as can be easily imagined, this lack of military status produced a crop of difficulties. The balloon detachments were usually drawn from nearby regiments, a lack of system which much increased the difficulties of working. There were also several changes in administrative responsibility, from the Topographical Bureau to the Quartermaster Department, and from the latter to the Corps of Engineers. Finally the balloon corps and train were disbanded in June, 1863, having existed for less than two years.

To revert to Lowe's activities. After November, 1861, there were four balloon detachments, at various points along the lines of the Potomac, controlled by him. One of these detachments was under the aeronaut Paullin, in position on the lower Potomac, and, in December, Paullin and Colonel Small inspected the enemy's camps and batteries from the balloon, along a front of seven miles. Small estimated the enemy's force, opposite Hooker, to be not more than 12,000 men; he made a sketch map from the balloon which proved to be useful.

Away in the West there was the aeronaut Steiner, whose services were not made use of by Halleck, Pope and the army commanders generally. Steiner had been sent to Cairo, Illinois, for duty with the Army of the Mississippi, but he was treated with complete indifference. The only occasion on which he was permitted to be of some use was when Commodore Foote helped him and placed a flat-boat at his disposal, so that the balloon and generator could be taken down the river to the gun-boat fleet. Steiner made an ascent on the 25th March, 1862, but the weather was too hazy for observation. But the next day he and two officers went up. The day was clear and it is recorded that they were able to correct the fire of the Federal mortars and that "the Confederates were driven from their batteries."†

It may fairly be said that, when the balloonists were given a fair chance in the Civil War, they showed that they could provide useful, and in some cases, important, information. But in many cases they met with hostility on the part of those in high command, and even when this was not the case, their want of army rank and the cumbrous official machinery, and especially the constant changes of the personnel of the ground detachments, militated against efficiency. They were, most of them, good aeronauts, who did their best in difficult circum-

**Aeronautics in the Union and Confederate Armies*, p. 226. By F. Stansbury Haydon. The Johns Hopkins Press, 1941.

†*Aeronautics in the Union and Confederate Armies*, p. 397.

stances, and it should be remembered in their favour that, in all the history of war ballooning since 1783, it was they chiefly who were able to contribute something of really definite value to the conduct of the operations.

*British War Ballooning.* In the *Foreword* to Mr. Stansbury Haydon's book there is the remark that "The balloon service of the Army of the Potomac operated with creditable success, and deserves added recognition because of its direct influence in leading to the later adoption of aeronautics in the British army." Let us, then, see what was the course of events in Britain which led to the original formation of the Balloon Detachment R.E.

The first British soldier to be prominently identified with ballooning was Major, afterwards General, John Money, who was born in 1752, saw a good deal of active service abroad, was taken prisoner in America in 1777 and was not released until the end of the war. He made several ascents in free balloons, and narrowly escaped death in a balloon misadventure off the East Coast, near Yarmouth, in 1785. In 1803 he wrote *A Short Treatise on the Use of Balloons and Field Observators in Military Operations*, in which he quotes the employment of balloons at the Battle of Fleurus and the "Lesser known case of the victory won by the French over the Austrians on the Ourthe River near Liège." But nothing came of his efforts. And the same must be said of Henry Coxwell's efforts to interest the authorities in military ballooning.*

In 1854, at the time of the Crimean War, Colonel Lefroy, R.A. "recommended that a balloon be built at the School of Military Engineering . . . This time a board of nine officers was named to consider the plan, and again an unfavourable report was rendered." It is remarked by Gamble that the youngest member of this board was sixty-five years old.†

Next we hear of Lieut. Grover, R.E. who sent a memorandum to the War Office, in which, having consulted the Greens, father and son, who were skilled aeronauts, he put forward a scheme for the provision of a balloon section with the Army. Then, Captain F. Beaumont, R.E., who "Had attached himself as an amateur to McClellan's force, and whilst with him took a deep interest in the ballooning experiments then carried on . . . joined Grover in his struggle, with the result that both were attached" to the Ordnance Select Committee as Associate-Members. Balloon ascents were carried out by them "at Aldershot on July 14th, 1863, and at Woolwich on October 6th of the same year."

Grover, Beaumont and Sir Frederick Abel discussed the best method of producing hydrogen in the field, and other matters of balloon equipment. But it would be tedious to follow in detail the various attempts which were made to persuade the authorities that a balloon establishment might be of service to the Army, and we may come at once to the seventies when Major Templer (7th Batt. K.R.R.) and Watson took several free runs,‡ and to the eighties when, thanks chiefly to the efforts of Watson, Templer and Trollope, a small balloon detachment was actually formed at Chatham; the junior officers, however, who carried out most of the actual ballooning, were only attached to the detachment and were borne on the strength of another unit. Amongst those mentioned by Whitworth Porter as having been thus employed were Macdonald, Mackenzie, Phillips, H. B. Jones and G. M. Heath. In 1887-88 we find that the Balloon Detachment, at Chatham, had a fairly well-established position, with a small manufactory of balloons, a gas-producing plant, seventeen officers and men, and a small money vote. Major H. Elsdale and subsequently Major Watson, were in command; and Major Templer was, nominally, the Instructor. But this is not a treatise on the technique of military ballooning, and we may, at once, describe, in brief, the war experiences of the British Balloon Detachments.

***The History of Aeronautics in Great Britain*, p. 179. By J. E. Hodgson. Oxford University Press, 1924.

†*The Air Weapon*. I, 42, quoted by Haydon.

‡*Watson Pasha.* Stanley Lane-Poole. John Murray, 1919, p. 85.

*Bechuanaland*, 1885. The Bechuanaland Expedition, which was commanded by Sir Charles Warren, included amongst its units a Balloon Detachment, under Major Elsdale, with Lieutenant Trollope, Grenadier Guards, as his assistant. The detachment consisted of eleven sappers. There were three balloons with their equipment. "It was found that owing to the high level of the ground from which observations were to be made, the lifting power was much diminished." However, some ascents were made, and at Mafeking Sir Charles Warren went up and remained up some time, a fine view of the country being obtained. It is not reported whether any useful information resulted, but there can be no doubt that the balloon impressed the natives, and this may count as a secondary advantage. Elsdale came home afterwards and commanded the balloons at Chatham.* He was one of the pioneers of balloon photography, having as early as 1883, when in Halifax, Nova Scotia, carried out some successful experiments with small balloons, which took up an automatic camera.

*Red Sea Littoral, Tofrik*, 1885. In Colonel Sandes' admirable book † there is an account of the use of balloons during the operations on the Red Sea littoral, in the spring of 1885. On the 25th March, a balloon was sent out with a convoy, from Suakin to the zariba at Tofrik, three days after the action, called usually the battle of McNeill's zariba. Major Templer, who was in charge of the Balloon Detachment, describes how, at daybreak, they started from Suakin, Lieut. Mackenzie being in the car of the balloon, at a height of 400 feet. The balloon was then carried, inside the square, for the seven miles march, towed by a rope attached to a wagon, drawn by horses. There was a good view. The balloon had been filled by hydrogen from cylinders. At Tofrik the balloon was hauled down and packed and taken back to Suakin. Whitworth Porter gives in detail the various messages received from Mackenzie in the car of the balloon, during the seven or eight hours that he was in the air. Mackenzie was able to see our troops, and camels, and small bodies of the enemy, up to a few miles away.

The balloons accompanied Graham's force to Tofrik on 2nd April, but strong wind prevented their use for some days, one balloon being split and the gas lost. "However, on April 24th, at Tambuk beyond Handub, a small balloon named 'The Fly' was inflated and sent up to an altitude of 1,200 feet so that the observers could watch the roads leading into the mountains towards Sinkat . . . On the following day 'The Fly' ascended to more than 2,000 feet and a view was obtained to a distance of 28 miles."

There can be little doubt that the balloons were of some use on these occasions.

*The South African War*, 1899-1902. And now we come to the last instances of the use of balloons by the British Army in war, during the period indicated. It has been mentioned above that the plateau of South Africa is not an ideal country for the employment of balloons, on account of its height above sea level and the consequent lack of "lift." Even Ladysmith is more than 3,000 feet above the sea.

*Ladysmith*, 1899. The 2nd Balloon Section, under Major G. M. Heath was part of the garrison during the siege, and before the investment was able, at Lombard's Kop, to do useful work in directing artillery fire. "During the month of November the balloons were frequently used, and gave good information with regard to the position and movements of the Boers, who particularly disliked this new implement of war." But the supply of gas gave out during the siege, and the employment of balloons had perforce to cease.‡

*Magersfontein, 11th December*, 1899. The 1st Balloon Section, commanded by Captain H. B. Jones, was present at the Battle of Magersfontein. Watson notes that this Section was usefully employed in observing the enemy's positions,

**History of the Corps of Royal Engineers.* Whitworth Porter. Vol. II, p. 194.

†*The Royal Engineers in Egypt and the Sudan.* By Lieut.-Colonel E. W. C. Sandes, 1937, p. 74.

‡*History of the Corps of Royal Engineers.* Vol. III. C. M. Watson, pp. 85, 90, 102.

and the *Official History* says that "thanks to the help of the balloons, the howitzer battery obtained the range of the Boer ponies, concealed behind the ridge, and accounted for more than two hundred of them."

*Paardeberg, February,* 1900. The 1st Balloon Section was employed during the investment of Cronje's force; ascents took place frequently, sketches were made, and artillery fire was directed. "The Balloons were hit several times, but not seriously damaged." The last day on which the 1st Balloon Section made good use of a balloon was when the Section was outside Pretoria on the 5th June, 1900. After this it was attached to Gen. Pole Carew's force in the Eastern Transvaal, until, after a severe storm on the 2nd August, when the force lost a large number of draught oxen, the balloon oxen were taken over by the Naval Brigade and the R.G.A., to replace casualties. The 1st Balloon Section was finally disbanded on 29th November, 1900, and the personnel transferred to other units.* About the same time the 2nd Balloon Section was converted into a Field Troop.

*Fourteen Streams, 7th May,* 1900. The 3rd Balloon Section, under the command of Major R. B. D. Blakeney, was present at this engagement and is reported as having done excellent service in "reconnoitring the enemy's defences, and in directing the fire of a 6-inch gun which had been brought up from Kimberley." The Boers are said to have evacuated their position largely on account of the moral effect of the balloon.

It is clear from the above four instances of the use of balloons during the early part of the South African War, that they did play a valuable part in the reconnaissance of the enemy's position and, occasionally, in the direction of artillery fire. The existence of a balloon was a trouble to the Boers, who probably thought that more was visible from up aloft than was actually the case. The balloon detachments were, no doubt, worth their transport, and that was the crux of the matter. Later on, the usefulness of the balloons diminished as a result of the character of the campaign, and we hear no more of their employment. Towards the end of the year 1900, the system of having many small independent columns did not lend itself to the use of balloons. However, they had done good work and had justified their existence.

*Conclusion.* Looking back upon those hundred and twenty years, at the balloon reconnaissances at Fleurus, and on the Ourthe; at La Mountain's ascent at Fortress Monroe; at McClellan's ascent at Arlington, and the several other occasions of observation from balloon during the American Civil War; at the use of balloons in the Sudan, and their employment at Ladysmith, Paardeberg and Fourteen Streams; it is clear that reconnaissance from balloon could be of value, given reasonably favourable conditions, including in such conditions a friendly attitude on the part of the military command. It is ill work prophesying, but it looks as if this use of balloons was a finished chapter; they are now relegated to the comparatively humble, albeit necessary, task of providing anti-aircraft barrages. But those who, many years ago, took a leading part in Great Britain in advocating and in establishing their use for military purposes, namely, Money, Lefroy, Grover, Beaumont, Watson, Templer, Trollope and Elsdale, did good work for the Army and deserve to be remembered, as also do those officers, such as Capper, Heath, Phillips, H. B. Jones and Blakeney, who took part in the practical development and employment of military balloons in the British Army.

*From information kindly supplied by Colonel H. B. Jones, C.B.

## *GORDON RELICS.*

THE *Chief Royal Engineer* has recently received from Mrs. A. A. Hamilton, as a present to the Corps, the gift of certain articles belonging to and letters connected with Major-General Charles Gordon who, when Governor General of the Sudan, was killed at Khartoum by the troops of the Mahdi on January 26th, 1885. Mrs. Hamilton, who is the widow of the late Major E. C. Hamilton, 3rd Hussars, has had the custody of these articles for some years; they came into her possession from her father, Mr. D. Lorn Macdougall, who was a personal friend and connection by marriage of General Gordon.

These relics comprise :—

1. A yellow embroidered silk Riding Jacket, which was presented to Charles Gordon by the Emperor of China in 1864 in recognition of his services in the suppression of the Taiping Rebellion.
2. An embroidered silk hood, presumably worn with the above.
3. A *copy* of a letter dated Windsor Castle, 16th March, 1885, from Queen Victoria to Miss Gordon thanking her for the present of Charles Gordon's Bible.
4. A letter in Arabic from Charles Gordon to the Mudir of Dongola dated 22nd June, 1884. This letter measures $1\frac{3}{4}'' \times 1''$ and was secreted in the spear head of the messenger who carried it.
5. A *copy* of a letter dated Camp Korti, 5th March, 1885, from Lord Wolseley to Charles Gordon's brother, lamenting his death.
6. A *copy* of a letter dated Windsor Castle, 16th March, 1885, from Sir John Cowell to Miss Gordon, forwarding Queen Victoria's letter of the same date.

It is intended to frame the Riding Jacket and Hood and to hang these temporarily in the Headquarters Mess at Ripon. The letters will be stored and, eventually, after the war, will be displayed in the Corps Museum alongside the other Gordon Relics.

The Chief Royal Engineer has thanked Mrs. Hamilton, in the name of the Corps, for her generous contribution to the collection of Gordon Relics already in our possession, to which they form a most valuable addition.

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The following is the text of the various letters :—

H.M. Queen Victoria to Miss Gordon.

Windsor Castle,
16th March, 1885.

" Dear Miss Gordon,

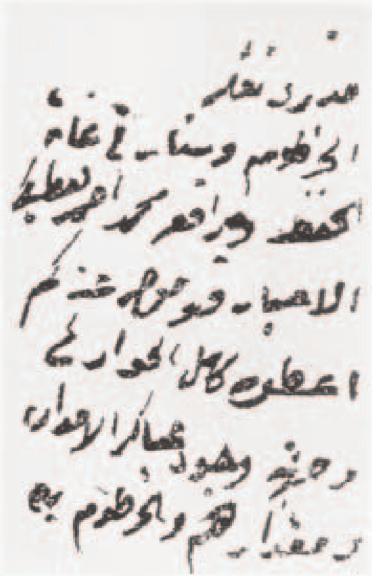
It is most kind and good of you to give me this precious Bible and I only hope that you are not depriving yourself and family of such a treasure if you have no other. May I ask during how many years your dear heroic brother had it with him? I shall have a case made for it with an inscription and place it in the Library here with your letter and the touching extract from his last to you.

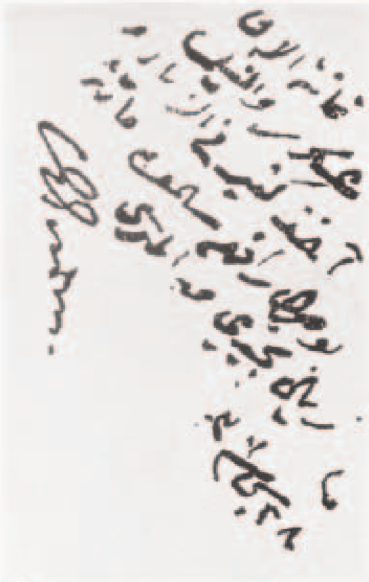
I have ordered as you know a marble bust of your dear brother to be placed in the Corridor where so many busts and pictures of our greatest generals and statesmen are, and hope that you will see it before it is finished to give your opinion on the likeness.

Believe me always,
Yours very sincerely,
(Sgd.) VICTORIA, R. & I."

GENERAL GORDON'S LETTER. 22nd June, 1884.

(Actual size $1\frac{3}{4}$ in. × 1 in.)





*Translation.*

*(First side)*

Mudir of Dongola Khartoum and Senaar in perfect security and Mahomed Ahmed carries this to give you news and on his reaching you give him all the news as to the direction and position of the relieving force and their numbers and as for Khartoum there are in it

*(Second side)*

8000 men and the Nile is rapidly rising: on arrival of the bearer give him 100 reals mejidieh from the States.

(Sgd.) C. G. GORDON.

**General Gordon's letter**

Sir John Cowell to Miss Gordon.

Windsor Castle,
March 16th, 1885.

"Dear Miss Gordon,

Whilst forwarding you the enclosed letter from the Queen, I am commanded to convey to you Her Majesty's best thanks for the photograph which she was much pleased to receive from you with the treasured Bible, which is to have an honoured place amongst the greatest treasures here, and I am sure there is none the Queen will value more highly or that the many visitors here will regard with greater interest.

Yours very sincerely,
(Sgd.) J. C. COWELL."

Lord Wolseley to General Sir Henry W. Gordon, K.C.B.

Camp Korti,
5th March, 1885.

"My dear Gordon,

I have postponed writing to you from week to week hoping I might hear if not good news at least some definite information to give you about your heroic brother. Bye and bye we shall, I have no doubt, be able to ascertain more particulars of his death, for dead there can be little doubt he is. Had Mohammed Ahmed caught him alive he would I think have kept him a prisoner for his own political purpose, but he was killed before that fellow could catch him; besides I don't think he would ever have allowed himself to be taken alive; in his journal he discusses the propriety of blowing himself up. I have read through the 6 vols. of his journal which came into my hands and it was indeed sad reading for me: I think that if Mr. Gladstone had sent us out a month ago, even a week earlier, your brother would now, in all human probability be alive and well. Believe me, my dear Gordon, we all here did everything we could do to save him. When first Gen. Stewart was wounded, some valuable time was lost, for the steamer ought to have started at daybreak on 22nd and not to have waited until 7 o'clock a.m. on the 24th January; this might have made all the difference. I always thought the appearance of one or two steamers with British soldiers on board at Khartoum would at any time have saved the place—my plans were based on this conviction. I sent a camel load of red clothing across the desert in order to dress up the detachment of the Essex Regiment that I had ordered Wilson to take with him to Khartoum as soon as he could after reaching the Nile near Shendy. I find from your brother's journal that he thought the arrival of such a steamer would also have saved him: just think how nearly all these plans succeeded and then picture to yourself our horror when Wilson returned with the news that Khartoum had been taken and your brother killed. Sorrow and rage was in every man's heart—sorrow for the gallant soul we had striven with might and main to save: rage at the Ministers whose folly had prevented the effort to reach Khartoum being undertaken earlier. Well, he is gone from amongst us and I shall never know his like again: many generations may come and go without producing a 'Charlie Gordon.' His example will be one that fathers will hold up to their sons in England, and as long as any faith in God remains to us as a nation and that we continue to be manly enough to revere the highest form of courage, so long will your brother be quoted and referred to as the human embodiment of all manly and Christian virtue. I hope his journal will be published *in extenso*. I am ordered to send it to Baring and have done so. I am now sending him all the original telegrams that left Khartoum whilst the line remained uncut: many of them should be published with the journal; a quantity of letters addressed to your brother and some letters to Miss Gordon which I found in the leaves of the journal. He wrote to me about his money matters and that letter I have made official and forwarded to the Secretary of State for War, saying that I felt convinced the debt he referred to would be at once settled by the Government.

Writing to you it would be silly to refer to my feelings: I never knew but *two* heroes; one has been dead many years and your brother was the other. We are now to have an Autumn campaign of some magnitude, but your brother's death has removed the great point of interest which we all felt in this country.

Goodbye my dear Gordon, you shall hear from me again when I have anything to tell you worth stating.

Yours very sincerely,
(Sgd.) WOLSELEY."

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## NOTE ON THE YELLOW JACKET PRESENTED TO C. G. GORDON BY THE CHINESE EMPEROR 1863—1864(?)

In February, 1863, Burgerine's troops were placed under Major Gordon. He held the command till May, 1864, when the neck of the rebellion had been broken and the "Ever Victorious Army," having done its work, was disbanded.

The Chinese Government, in its gratitude for his great services, not only made him a Mandarin of a very high order but also gave him the rank of Ti-Tu—the highest in their army.

In the decree that the Emperor issued, he said:—

"We command that Gordon be rewarded with a yellow riding-jacket to be worn on his person, and a peacock's feather to be carried on his cap; also that there be bestowed on him four suits of the uniform proper to his rank of Ti-Tu in token of our favour and desire to do him honour.

Respect this."

# MEMOIRS.

## MAJOR-GENERAL C. H. COWIE, C.B., C.I.E.

Major-General Charles Henry Cowie, c.b., c.i.e. was born in April, 1861, the second son of David Cowie of Calcutta.

He obtained his commission as Lieut. in the R.E. in April, 1881. After the usual course he with a number of other young R.E. officers was appointed to the Bengal Sappers and Miners, sailing in the old troopship *Malabar* in September, 1883. The voyage was a long one as for some reason the *Malabar* was sent round the Cape, stopping only at Las Palmas and Capetown for coaling. Accommodation on these old troopships was not luxurious, especially for subalterns, who lived on a lower deck known as Pandemonium, very badly ventilated and abominably hot in the tropics.

At the Cape he took part in a drag hunt to Wynberg, got up somehow by that indefatigable huntsman, A. H. Cowie.

On arrival at Bombay he with others was ordered to join the Sappers at Sibi as five Companies had been sent there for employment on the "Hurnai cart road" as it was called, really a broad gauge railway up the Hurnai pass to Quetta, under Colonel James (Buster) Browne, R.E.

He soon found that as second of a Company there was little to do watching a few sappers working and on approaching Colonel Browne was given a job on a section of the line under Capt. Chandos Hoskyns and was shortly after appointed an Assistant Engineer in the Railways, where there was more than enough to do. The line had been roughly surveyed during the Afghan War of 1878–80 and easy parts of it had actually been started. The country was very difficult and the line selected was a bad one, work had to be hurried and there was not time for survey, but when the heat had necessitated work stopping on the lower parts of the pass and all labour was transferred to the higher ground, a re-survey was made of it. It fell to Cowie's lot to survey the highest part, which rises to about 6,000 feet with a sudden drop on the far side and includes a nasty formation known as Mud Gorge, where the hill slopes push the ground down to the river. After the formation had been made through the lower spurs one often found the cutting only half its width and the bank some yards clear of the cutting. Cowie managed the steep descent by making a corkscrew, the line going round and under itself, and ultimately got over the chief trouble of the sliding hills, a very creditable performance for a young and inexperienced engineer. Life was hard and had little relaxation except an occasional day shooting sisi, chichor or blue-rock pigeon, or an hour's fishing for small mahseer in the stream. He once caught a snapping turtle in a deep pool and nearly had his finger bitten off. He suffered a good deal from malaria which was rife and had to turn to doctoring when all work was stopped owing to a bad epidemic of cholera, and most of the coolies deserted. He remained until the work was finished and the line was through and later received a bonus of a month's pay for each year's service there, given by Government in recognition of the hardships they had endured to officers selected for their special good service.

For a short time he was employed in the M.W.D. at Rawalpindi and then in the P.W.D. at Calcutta.

Most of his life was spent in the service of railways in India and after a few years he was generally employed in the Management branch. In 1890 he accepted the offer of a Division, under Colonel Buchanan Scott, R.E., on a survey for a railway from Quetta down the Zhob Valley to Dera Ismail Khan, which was planned entirely for strategic reasons. The line was to run through Tank over easy country to Murtaza where the Gomal river debouches from the hills and the difficulties begin. His Division was allotted the lowest section as far as Nili Kutch. The Gomal flows through bare rocky hills and the line keeps necessarily close to the river bed and entails steep gradients, sharp curves, heavy earthwork and many tunnels. Cowie's experience on the Hurnai Railway was invaluable to him.

The country has a very small population of Waziris, who eke out a scanty living by raids on the caravans which come down the Gomal every cold weather and to whom unarmed survey parties would be an easy prey, so each Division was furnished with an escort of 25 Sikh soldiers and a "badraga" or safe-conduct of 12 Waziris. The country supplies nothing, so each Division had a number of camels working to and from Tank. These had to be escorted. In the cold weather the river is low and easily fordable, though subject to sudden floods which give no warning. Work was hard, entailing numerous trial lines to get the best alignment and the cold was often severe, but there was little sickness and except for one or two unsuccessful raids on the camels was uneventful and all outdoor work was successfully completed before the hot weather, when the survey parties went to Dalhousie to plot results, select the final alignment and work out the probable cost.

Life was a pleasant change there and all enjoyed it. Unfortunately Cowie succumbed to a sudden attack of influenza which swept over the place and had it badly, not fully recovering for some months.

On completion of the survey in 1892, Cowie was appointed Assistant Manager of the Eastern Bengal State Railway. He took a well-earned furlough from 1893 to 1895, after which he returned to India.

On arrival in October he was posted to Waltair as Deputy Manager for construction on the railway from Madras to Calcutta, until March, 1896, when he was transferred to Calcutta as Deputy Manager of the Eastern Bengal State Railway. In July, an earthquake destroyed great parts of the line and he had a strenuous time on repairing it. By October the repairs were so far advanced that he could be spared to take up duty as a Field Engineer in the Tirah Expedition, being employed on the construction of a road over the Sampagha Pass. There he unfortunately had a severe attack of pneumonia which necessitated his being invalided to Lahore. When he recovered he rejoined his post on the E. Bengal Railway, where he remained until transferred to Lahore as Deputy Manager of N.W. Railway, and he went home to Chatham for a refresher course at the end of 1898. When the South African war broke out he volunteered for service but was refused, so he returned to India at the end of the year 1899. To his great pleasure on Christmas Day, 1899, he received orders for South Africa as A.D.R. under Sir Percy Girouard.

On arrival he was appointed Dep. Director of Railways, and retained that position until the end of the war, when his title was altered to Director of Imperial Railways, on Girouard taking a post under the Civil Government.

When peace was declared Lord Milner was anxious to retain his services, but he refused the offer and returned to India. For his services in S. Africa he received the Queen's medal with 3 clasps, the King's medal with 2 clasps, mention in despatches and the Brevet of Lieut.-Colonel.

On return to India he took up his old appointment as Deputy Manager of the N.W.R. under Sir Stephen Finney, acting as Manager when Finney went on leave. Lord Kitchener, then C.-in-C. in India, proposed to divide the N.W.R. making all the northern part a purely military line, and offered Cowie command of this part, but the project fell through owing to Kitchener's departure shortly afterwards.

In September, 1906, Cowie became Manager of the E. Bengal Railway at Calcutta, an appointment he held until illness compelled him to take 2 years' furlough (only his second long leave during his service).

Returning to India in 1910 he was Manager of the Oudh & Rohilkund Railway, until in 1913 he became Manager of the N.W.R. which was considered the most important railway in India. In 1916, having attained the age of 57, he had to retire from India and came Home, where his value was so well recognized that within a week of his arrival he was appointed Deputy Director of Railways, Eastern & London Command, under Sir John French. After the Armistice he went to Constantinople as Director General of Transportation under Sir George Milne, with temporary rank of Major-General, and in 1919 he retired with the same rank.

He was appointed a C.I.E. in 1915 and C.B. in 1919.

His long service in India had affected his constitution, and in 1921 it was necessary for him to avoid the English winters, so he and his wife took up their residence in the South of France where they spent the years quietly and happily until the tragedy of 1940 forced them to leave. He was not well at the time and the hardships they had to endure for days on a collier whilst escaping from France undoubtedly aggravated his illness. He never recovered and died in November, 1941.

He married in July, 1895, the widow of Captain Herbert Franklin Crohan, R.N., who survives him.

Charlie Cowie was the happy possessor of an equable temperament, enjoyed a quiet life and had a strong sense of humour. He was a good oar, a fair shot and a keen fisherman, joining in any amusements that were going. Though so quiet in manner he knew how to make himself obeyed, and always got good work out of his subordinates, with whom and with those over him he was deservedly popular. He was an able and conscientious public servant, and leaves behind him a record of which any R.E. officer might be proud.

J.E.C.

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## *BRIGADIER H. G. EADY, M.C., p.s.c.*†.

HAROLD GRIFFIN EADY was born on the 11th February, 1894, and educated at Clifton and the Royal Military Academy, where he took the first place with a prize cadetship. He was gazetted Second-Lieutenant, Royal Engineers, on the 1st October, 1913, and went to France in December, 1914. From December, 1915, to December, 1916, he was Adjutant to the C.R.E., Guards Division, and then joined the 55th Field Company, R.E., in that Division. Promoted Captain in November, 1917, after some service as G.S.O. at Corps Headquarters, he became in March, 1918, Brigade Major, 120th Infantry Brigade and held that appointment until September, 1920. He was three times mentioned in Despatches and received the M.C., the brevet of Major, and gained the *Croix de Guerre* with palms.

After the war he commanded a company of Gentlemen Cadets at the Royal Military Academy for four years, was at the Staff College in 1924-25, and for four years a G.S.O. at the War Office. In 1930 he served at Gibraltar as Assistant C.R.E., and then became Brigade Major and Secretary at the S.M.E. From

1933 until 1936 he was G.S.O. at the Staff College, and later studied at the Imperial Defence College. In 1938 he was promoted Colonel, with antedate to July, 1936. In 1937 he was selected to make an official visit to the military authorities in the Dominions and Colonies and it was his success in this mission which led to his appointment, after a short term as D.D.M.T. at the War Office, where he was a Brigadier, to be head of a military mission to the Union of South Africa, and Military Adviser to Lord Harlech, the High Commissioner. He met his death on 16th October, 1941, in an aeroplane accident at Tandjiesburg, Natal, and was buried with military honours at Roberts Heights Camp on October 21st.

Eady was the author of a number of military writings, including *Historical Illustrations to F.S.R.*, which went into more than one edition and had a wider public interest than its title promised, and he also contributed to these columns many reviews on books of Military History. He was a keen hockey player, having been in the Eleven at the Royal Military Academy and in the Corps Eleven. Later he played for the Army and was a member of the English Selection Committee.

Though an untiring worker, he took a lively interest in those serving under him and could always find time to give a sympathetic ear to their problems and difficulties. He had a happy gift for mutual friendliness with those serving in the ranks and their families and will be remembered by many as a friend as well as a distinguished officer.

The Army and the Corps are the poorer for the untimely death of this brilliant officer.

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

# *BOOKS.*

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

## "FROM TOBRUK TO SMOLENSK."

By STRATEGICUS.

(Faber & Faber, Ltd., 24, Russell Square, London. Price 10s. 6d.)

In this, the third volume of the series, the author describes our successes in Abyssinia, Eritrea, Syria and Iraq, the set-backs in Greece, Crete and Libya, the battles of the Atlantic and in the air, and the first phases of the campaign in Russia. It covers roughly the period from December, 1940, to August, 1941. The narrative, illustrated by adequate maps, gives sufficient detail to enable the operations to be followed easily, and the comments are shrewd and to the point.

Throughout the author stresses the value of the offensive, founded on mobility, adequate training and close co-operation with the air force. This is especially exemplified in the record speed of the advance in Abyssinia, and special tribute is paid to the supreme endurance of the finely trained troops, who made this success possible. In Greece and Crete, too, no praise can be too high for our fighting forces of all three arms, and it may well prove that our losses there in men, equipment and ships will prove to have been a price worth paying for the postponement of the Russian campaign, and the frustration of dangerous hostile thrusts through Turkey and Syria to the Caucasus and the Suez Canal respectively.

In the war in the East, "Strategicus" considers that the Russian High Command concentrated too many Divisions (48) for the defence of Bessarabia, leaving 40 Divisions for the Sector North of the Pripet Marshes, which covered the capital, Moscow, and was thus dangerously weak.

Further he thinks that the Russians, instead of using up their forces in local counter-attacks, should have staged a strong counter-offensive. Voroshilov had a great opportunity for this in August, when the Germans had thrust forward to Smolensk, and exposed a very vulnerable northern flank.

From the subsequent course of the war it seems that the Russians were right in strengthening their left flank. This decision was probably based on the difficulty of holding the flat country of the Ukraine against *panzer* attack, and the necessity therefore of containing the enemy on the river lines for as long as possible.

As regards counter-attacks, the Russians did not complete their mobilization until the end of July. By that time the Germans were well on their way to Smolensk, and had by-passed large bodies of Russian troops. These men, although undoubtedly doing good work by holding out in the enemy's rear, as at Minsk, were eventually absorbed by the Germans, and with their equipment became a total loss to the defence.

This, incidentally, was our experience in the March, 1918, retreat in France, and it is probable that a somewhat earlier retirement, thus saving the bulk of the troops and their equipment, would have been more advantageous.

However, with modern fluid warfare, and with a front of over 1,500 miles, it is not surprising that the Russian retirement was not always synchronized, nor that counter-attacks on a large scale were not staged during the initial retreats.

The real surprise to the Germans, as well as to the world, was the fighting spirit and tenacity of the Slavs, and their subsequent wonderful come-back, a description of which it is hoped may be forthcoming in due course from the able pen of the author.

C.G.F.

## DELTAIC FORMATION.

With special reference to the hydrographic processes of the Ganges and the Brahmaputra.

By C. STRICKLAND.

(Longmans Green & Co. 157 pp., post 8vo. 72 Maps, Diagrams, etc. Price 9s. od.)

The author of this interesting and detailed study of deltaic formation is a Doctor of Medicine and a Professor of Medical Entomology at the School of Tropical Medicine, Calcutta. As Professor Frank Debenham remarks in his Foreword "it is unusual . . .

to find an expert in one branch of science applying himself to problems of another branch removed from his own. The result often is that new light is thrown upon the subject . . . but . . . naturally terminology and metaphors are unusual." With this most readers will agree.

After referring to and rejecting various attempts to define the area of a Delta, the author concludes that no such definition is possible, since areas of deposition at one epoch will become areas under erosion at another. He then describes the normal process of deltaic formation in a lake or tideless sea "The sediment-laden currents thus moulding the sea-bed disperse over the surface of the sea, and meeting the drag and deadweight of the opposing waters may be considered to arrange themselves fanwise and each to resolve into two . . . distributaries following the lines of least resistance. Then in the comparatively still area between these, as well as along the laterally opposing masses of seawater . . . banks of sediment are thrown down, these, in the latter situation, being continuous with the banks of the river before its debouchement at the sea face. The diverging currents" (*i.e.*, the "distributaries" from adjoining "currents") "now join forces and naturally delimit the growth of the banks seaward and the combined stream becoming relatively more powerful . . . enables it . . . to pursue a straighter course, but as its profile flattens out it loses power and eventually the same process of distribution and bank formation is re-enacted." Later, these banks along converging distributaries are linked up to enclose lagoons which are clearly shown in maps of the Mississippi Delta at various periods.

In the case of the Ganges (and Brahmaputra), however, we have the powerful tidal currents at the head of the Bay of Bengal which materially affect this comparatively simple structure. These tides "set up opposing currents, so that the distributaries of the rivers flowing seaward in one phase convey in the other phase tidal currents that become tributary to one another," with the result that streams ultimately connect the rivers at right angles and are kept open by the tidal current. The navigable cross channels of the Bengal Delta are an important example of this and provide the means for water transport from the Hooghly river of Calcutta to many parts of Eastern Bengal.

Another result of these tidal currents is the formation of a ridge of slightly higher ground near the sea face. These currents bring back or hold up the silt-laden waters for a period sufficient for them to deposit their load. Further inland where tidal action is less, the simpler action described earlier occurs and we have the lagoons or "bhils" of the Bengal Delta which stretch for "hundreds of miles" eastwards from the Salt Lakes of Calcutta. Some of these are scars of old river beds, but many are "lagoons," a part of normal deltaic formation. The author rejects, probably correctly, the theory that this low lying area is of diastrophic origin.

Another factor in the formation of the Bengal Delta is the change that has occurred in geologically recent times in the rivers forming it. Reference is made to the theory that the Assam Brahmaputra once flowed westwards along the Ganges and Indus valleys. Much later the Teesta, once a tributary of the Ganges, was captured by the Brahmaputra and the extra waters forced new channels or enlarged minor ones. Further repercussions on the Ganges then occurred. Its waters were dammed back above Goalanda and it too had to find new outlets, thus adding to the complications of deltaic formation.

Dr. Strickland deals with many other aspects of river physiography, erosion, meanders, salinity, seepage and finally with their death. He handles a large canvas and its vastness must be the excuse for a certain lack of cohesion in presentation.

Many of the illustrations are excellent but some of the diagrams suffer by being reproduced on too small a scale for legibility. Misprints are very few but the word "heighth" occurs several times and Major Hirst was neither R.E. nor "Surveyor General with the Government of India."

H.J.C.

## "THE STORY OF ELECTROMAGNETISM."

By Sir William Bragg, O.M., K.B.E., F.R.S.

(Messrs. G. Bell & Sons, Ltd. Price 1s. 6d. net.)

The foundation of this little book is a lecture given by Sir William Bragg to cadets of the Air Training Corps. The book is in historic vein and shows how one idea led to another, and how the pioneering discoveries of Galvani and Volta made possible the establishment of a connection between Electricity and Magnetism by Oersted. This led to Ampère's investigation of the neutral action of two wires carrying a current and thus to Faraday's great experiments. Clerk Maxwell then played an essential part by putting Faraday's conceptions into mathematical form, thus paving the way for the discoveries by Hertz and Branley which led to the transmission of signals by radio. The book is profusely illustrated by pictures and diagrams, though many of the latter are unnecessarily crude; but for immature minds no book of this type can be a satisfactory substitute for the realism of an enthusiastic lecturer.

This little volume illustrates the wisdom of the Junior Service in catching its trainees at so early a stage. Those who are undertaking the wartime training of cadets destined to officer the technical services of the Army can ill-afford to spare a single moment on mere luxuries such as a study of the methods whereby the Victorian pioneers blazed the trail. But no one doubts that when time permits the study of the developments of the past provides a fruitful source of new ideas as well as helping in the understanding of fundamental principles.

D.P.

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# *MAGAZINES.*

## *GERMAN TEMPORARY-BRIDGE BUILDING IN THE WEST.*

(*Translated from the German Periodical* "*Die Strasse—Die Autobahn*" *of July*, 1940.)

In order to hold up the advance of the victorious German Army in the West, the Dutch, Belgians, French and English blew up almost all the bridges in the battle zone. Pioneers sent to the Front Line achieved wonders in courageously crossing the streams, rivers and navigable canals of Holland, Belgium and Northern France, in getting the troops over by means of floats, barges, ferryboats and temporary footbridges, and in building pontoon bridges for the passage of motorized units and heavy artillery. "Bridging" Battalions were moved up to roads in the rear to erect river and canal crossings for the maintenance of supplies. Advance parties of the Todt Organization followed, with a military bearing, immediately behind the fighting troops, to make the roads serviceable for reinforcements. The Todt Organization, with the help of affiliated contractors and their great reserve of machinery, was also able to cope with difficult technical jobs caused by the lightning advance of the troops. There were also "Road and Bridge" Troops, formed by the Inspector-General for German Road Transport, who were brought up by the Transport Authorities for special duties. Over and above all this, it was necessary to repair the main bridges, build substantial temporary bridges and undertake (with the aid of pile-driving and steel-work contractors) the difficult and exhaustive job of clearing up and reopening the waterways. The principal *Reichsautobahn* contractors were entrusted with the organization and carrying out of these tasks and they were instructed to draw to a great extent upon local supplies of man-power, machinery and building materials in the occupied zones.

It will take months of hard work to open up navigable waterways blocked by fallen bridges, to dredge the rivers and get rid of debris damming them up, in order to avoid damage at high water and general obstruction. On the other hand, it is comparatively easy to restore steel bridges that have been blown up, in cases where only parts of the superstructure have been destroyed. Collapsed superstructure, which has only been severely damaged near the points blown up (and which it is therefore possible to turn to use again) is lifted on to platforms by means of hydraulic pressure rams and joined together with freshly inserted construction-links. It is more difficult to re-establish steel bridges which have been collapsed through the ruining of a pier or supporting base. The difficulties of removing debris from bridges in a fast current are very great and are often grossly underestimated. The fallen superstructure has to be partly dissected by divers with a special tool for cutting the steelwork under water and then raised by floating cranes. In the case of reinforced-concrete bridges and arched stone bridges, large parts have to be dissected by blowing them apart under water and removing them. In cases of this kind it is exceptional that road communications can be speedily re-established at the former bridging points. It is generally advisable to circumvent the debris with a substantial secondary bridge, paying attention to the layout of the road and the approaches. Diversion has, moreover, the advantage that exhaustive demolition work can be carried on without interfering with the construction of the bridge.

Where the greater part of the bridge remains unaffected and usable and the cantilever can be safely balanced on a mined pier, a strong temporary bridge should be constructed across the former bridging point. It is immaterial whether this temporary construction is eventually found to obstruct the ultimate rebuilding of the old bridge. Instead of raising the damaged pier-shafts, the completion of the superstructure can be speedily effected by placing yoke beams on the base, anchoring them fast at the bottom and, where necessary, protecting them with ice-breakers.

As a rule, substantial temporary bridges have a double track with a six-metre minimum carriageway and a railing half a metre high on either side. Wooden bridges designed for Army traffic must at least conform with the minimum load of Class II Bridges (16 tons DIN 1072). It is possible to allow for the passage of caterpillar traffic, in single file, up to 36 tons total weight, by adding a double layer of planks on the carriageway and arranging supports to distribute the weight. Strong temporary bridges with steel girders, reinforced-concrete slabs and planks are calculated as Class I Bridges (24 tons, DIN 1072). Emergency and temporary bridges quickly erected for the rapid passage of troops, often impede the flow of the river still further and are constantly endangered at high water. In addition to this, parts of the damaged bridge below water level begin to sag as a result of corrosion and the emergency bridge is rendered unsafe. Such emergency bridges as these should be removed at once and replaced by strong secondary bridges. Bridges should be strengthened, if the maximum load capacity is insufficient, by constructing additional props, supports and so on, and temporary bridges with yoke beams too near the surface of the water should be replaced by substantial secondary bridges.

The "Bridging" troops and building concerns of the Todt Organization were given a great many large and small building jobs, and they had to be on the spot during an attack and accomplish their work in the shortest possible time. The manpower, building material and machinery required for all this necessitated careful inquiries and preparations. The first inquiries for the repair of larger bridges were instituted by Bridge Engineers of the chief building concerns, who estimated the nature and extent of destruction, made notes of constructive details and the main measurements, took photographs of the effect of the demolition and examined the breadth and depth of the river, the speed of the current, the building terrain and shape of the shore, high water level, freezing conditions, etc., etc. Even at the first examination, suitable measures for reconstruction are considered and rough sketches for the new bridge made. The decision as to suggested measurements, etc., is influenced by the disposition of available workmen and implements, by the materials required and transport facilities, as well as the estimated total cost. The working out of plans is simplified and hastened if drawings of the demolition are brought forward by road, river and shipping authorities. To guarantee a quick and suitable construction, careful inquiries, extensive building preparations and designs worked out thoroughly in every detail are essential. Insufficient preparations lead to loss of time and squandering of power and material. When the bridge is finished, the platforms and road-connections must be firm and usable.

To solve the problem of reconstructing gangways and other minor erections, as well as bridges with narrow arches, where the piers and bases have remained intact, reinforced-concrete cylinder supports and reinforced-concrete slabs are employed. The former require a comparatively large amount of steel but are easy and quick to carry out.

H.T.T.

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## *THE MILITARY ENGINEER.*

(*September*, 1941.)—With the September number "The Military Engineer" has taken on a new form. In future it is to be published monthly, instead of bi-monthly. It is proposed to include in it articles on civil engineering generally, as well as articles of interest to military engineers, the idea being to cater for the requirements of the large number of civil engineers who will be called upon to serve as military engineers during war time.

*Military Uses of Photography from the Air.* By W. Clark and Captain R. R. Arnold.

Great strides have been made in aerial photography since the first World War. At that time photographs were taken at an altitude of 10,000 feet or less, whereas the present doctrine contemplates photography from 20,000 feet or higher. At 20,000 feet a single picture can be made to cover 300 square miles by the use of tandem five-lens cameras mounted at an angle of 45 degrees. In the first World War photographs were taken largely on orthochromatic film, to-day highly sensitive panchromatic emulsions having great speed, infra-red film capable of cutting haze and photographing for great distances, as well as colour film, are available.

For mapping photography at altitudes of 20,000 feet great film speed is not particularly important—a usual exposure is 1/100th of a second. For intelligence work, however, great film speed is essential.

Considering the conditions under which aerial photographs are taken in war time, results have been very satisfactory.

*Limitations on Barrier Tactics.*

Captain M. L. Thomas considers that the viewpoints on the employment of barrier tactics can be subdivided into two classes which he calls :—

(1) The " Endless Maze " school.
(2) The " They Shall not Pass " school.

The " Endless Maze " conception requires the establishment, by engineer means, of a complex system of barrier lines, which divide up the defensive area into a series of interlocking irregular cells to a depth of 30 to 50 miles in rear of the front lines. (A diagram explains the writer's meaning.) The effect is progressively to weaken the penetrating force and to canalize and slow it down until it can be wiped out by the reserves.

The exponents of the " They Shall not Pass " conception place their main reliance on counter-attack. They want strong reserves, and the rear areas free from barriers. A limited number of strong barrier lines is employed to protect the main position.

After discussing the two systems, the writer concludes that a weak defence would be more likely to adopt system (1), whereas a force strong in tanks, armoured divisions and combat aviation would prefer to employ system (2).

*Military Construction in the Atlantic Bases.* By Colonel J. D. Arthur.

In September, 1940, the United States acquired the right to construct military and naval bases in eight British possessions in the Atlantic Ocean. The construction of these bases has presented a variety of problems.

This article describes the conditions encountered, the preparation of designs and plans, and the giving out of construction contracts. Work is now well under way. Temporary housing for construction personnel is in hand, and the permanent projects are making progress.

*Engineers with the Armoured Forces.* By Colonel L. E. Oliver.

This article is confined in general to a discussion of the engineers with an armoured division, an organization established in the summer of 1940.

The armoured engineer battalion has a total strength of 25 officers and 704 men, and consists of a headquarters company, three working (*i.e.* field) companies, a bridge company, and a medical detachment.

Under the present organization the bridge company consists of headquarters, a floating bridge platoon and a fixed bridge platoon.

The floating bridge platoon consists of an assault-boat section with twenty assault boats, a ferry section with two 30-ton ferries, and a heavy pontoon section with 250 feet of 25-ton pontoon bridge.

The fixed bridge platoon has an H-10 bridge section with one unit (72 feet) of H-10 bridge, an H-20 bridge section with one unit (125 feet) of H-20 bridge, and a portable trestle section with 300 feet of bridge capable of carrying a 28-ton tank.

The above scheme is only tentative, and various modifications have been proposed. One is to eliminate the bridge company. Ferrying equipment is essential, but the assault boats could be replaced by small rubber boats, a few of which would be carried by each company.

The H-10 and H-20 bridges are not considered suitable for present needs : nor is the amount of fixed bridge material sufficient for the crossing of a river of any size. Various modifications are suggested. A girder treadway type of pontoon bridge, as advocated by Captain Swift in the May-June issue of *The Military Engineer* is a class of bridge capable of rapid erection.

Another suggestion is the increase in the working strength of the battalion by adding a fourth working company and providing a third platoon in each company. The provision of two anti-tank guns for each platoon is advocated.

*Emergency Road Helps.*

A few photographs are given, taken from German papers, illustrating portable " corduroy carpets " carried on motor vehicles to prevent the wheels from sinking in muddy or sandy ground. The " carpets " consist of pieces of green wood, 3 to 6 cm. in diameter, two and a half times as long as the width of the tyres. The pieces of wood are wired together with pliable wire. The carpet is about two metres long and can be carried, rolled up, at the back of the vehicle.

*(October, 1941.)—The Defence Airport Programme of the Civil Aeronautics Administration.* By Lieut.-Col. L. D. Clay.

The War and Navy Departments have combined with the Department of Commerce in pressing for additional appropriations for air-port construction. As a result, in July of this year, Congress increased the authorization from 250 to 399 air-ports, and appropriated $94,000,000 for the continuation of the programme.

The Works Projects Administration has developed additional sites to meet defence requirements. The Army and Navy have also improved a number of existing air-ports. The development of suitable air-ports is now keeping abreast with the delivery of aircraft. With the completion of the present programme there should be available in the United States and its continental possessions at least 87 Class 4 air-ports, and 370 Class 3 air-ports. This programme will have to be further extended as production and delivery increase.

*Organization of the Ground for Defence.* By Major A. A. G. Kirchoff.

The technique of field fortification has changed very considerably since the last war, owing to the manœuvrability and sustained action of the mechanized forces and the great striking force of the aeroplane. The technique of the attack by infantry, even though accompanied by tanks, has changed but little.

In a defensive position each platoon should be so organized that all its members can fire to the front from which the enemy attack is expected, and at least 25% to either flank from the position occupied, with an increase of 50% made possible by shifting a squad to an alternate position. Not less than 10% of the men should be capable of firing to the rear, with alternative positions prepared so that at least 40% of the fire can be brought to bear in that direction by the shifting of a squad. Defensive areas should be so arranged that their depth, as occupied, is equal to the front defended.

The writer proceeds to describe types of trenches, shelters and obstacles. A novelty in the way of a trench is the "Spider Hole": a round hole in the ground, about 4 feet deep, covered with a lid of sardine netting, which can be lifted when the occupant uses his rifle. If time permits, a pair of spider holes can be connected by a two-man shelter. An important point is the disposal of the soil in such a way as not to give away the position of the trench from above.

Such shelters as are necessary should be of the splinter-proof type. Bomb-proof shelters are difficult to conceal.

The mine is the most effective obstacle against tanks. Anti-tank mines should be carried by infantry, artillery, anti-tank and engineer units.

*Paper for Hasty Camouflage.*

Major Rodienko has been making experiments with materials suitable for camouflage. One of these was a fabric woven from yarn, made from paper pulp, and woven in a manner similar to that used in Japanese imitation "Panama" hats. The material is strong and gives satisfactory results.

Another material that has been tested is a sample of paper, technically known as 50-lb. kraft. It is manufactured in rolls 54 inches wide and is cut with interrupted longitudinal slits. It is stretched laterally on the same principle as expanded metal. This gives it an appearance resembling snake skin. It is flame-proof, light and strong. Good results were obtained by applying a coat of burnt umber paint on one side, and olive green on the other, both with a very dull finish.

*Planning Railway Routes for Big Guns.* By S. Blumenthal.

The writer, a member of the engineering staff of the Canadian Pacific Railway, has worked out tables for calculating the strength of bridges required to carry the largest railway-mounted guns. The axles of gun-mounts are spaced in a different manner from those of steam locomotives, and the distribution of the total weight over the wheels varies considerably in the two types of loading. The impact factor for railway guns is taken to be the same as that for electric locomotives, and is considerably less than that for steam locomotives.

*Power Supply in Warring Countries.* By H. S. Bennion.

Experience in the present war has shown that damage done by bombing has only temporarily dislocated utility distribution systems, *viz.*, electricity, water and gas. Overhead electricity systems have proved less vulnerable than those underground. On the other hand, the bombardment of Warsaw shows that large calibre artillery fire is more destructive than bombs to electric power stations, gas works and water mains. In Belgium it was found that a simple method of putting a generating station out of action was by breaking control instruments and insulators, which could not be replaced from available stock.

*Luminous Paint and Markers.*

Luminous materials fall into two general classes: fluorescent and phosphorescent. Of these, the latter are likely to be more useful to troops in the field, because they require only periodic activation.

One of the suggestions made is that of luminous button markers: circular discs 1 inch and 1¾ inch in diameter. The button has two eyelets for fastening it to stakes, and a clip or pin back for attaching it to clothing. These buttons have been found to be valuable for control, communication and identification, and, after tests, have been reported on favourably.

*(November, 1941.)—Engineers with the Army Air Forces.* By Colonel S. G. Godfrey

A description of the organization and equipment of the Aviation Engineer Regiment, and of the work for which it is trained.

Amongst the tasks allotted to aviation engineers are:—Improvement or provision of advanced aerodromes together with all services connected with the same. Communications leading to these aerodromes. Gas-proofing or bomb-proofing and camouflage. Defensive arrangements against ground and air attack. Maintenance and repair.

The aviation engineer regiment consists of three battalions; each battalion has three companies. A battalion has 220 pieces of heavy equipment, besides the ordinary tools, and 146 vehicles.

Aviation engineer units are not intended for peace-time construction, and have no rôle in the maintenance of air ports in time of peace, but they may be given definite construction tasks for training purposes. Even in war-time it is not intended that they shall carry out *all* airport construction work. They are primarily intended for "pioneer" work where speed is essential.

*Military Uses of Rockets.* By H. F. Pierce.

Rockets can be used for a number of different purposes in war-time. Communication rockets can be employed when other methods, such as radio or telephone, have failed. Rockets can be used for anti-aircraft work, their power being derived from the combustion of alcohol or petrol in combination with liquid oxygen.

The writer calculates that liquid-fuel rockets would range in size from 6 feet long (6 inches diameter) to 15 feet long (12 inches diameter), and that the larger sizes could reach an altitude of 30,000 feet in 50 or 60 seconds.

He advocates a greater expenditure of time and money on research work.

*Engineer Board Notes.*

This article describes the selection and testing of materials for camouflage. Those specifically mentioned are steel wool, rock wool, Spanish moss and thatch. "Straight line" chicken wire is considered preferable to the ordinary hexagonal mesh netting. Casein paints are being tested: they are considered more suitable than oil paints.

(*December*, 1941.)—*The Air Forces and Military Engineers.*

This article is a revision of an address delivered by Major-General H. H. Arnold, Chief of the Army Air Forces, in October, 1941.

In 1940 the American army had only about 2,000 planes, all told. The President now proposes to build additional planes at the rate of 50,000 a year.

General Arnold described the organization of the Air Force, its training programme and equipment, and the Air Corps Ferrying Command, which provides training for a number of pilots. He then went on to deal with the lessons of the present war.

The Army and Navy must have the whole-hearted co-operation of the Air Force. The single-engine fighter is, on account of its manœuvrability, superior to other fighter types, but it may have to increase its ceiling to above 40,000 feet. B-17's are already operating at 35,000 feet. Fighters can prevent the loss of a war, but heavy bombers are required to win it. The heavy bomber remains the back-bone of air power.

Air bases are a determining factor in the success of air operations, and this is where the military engineer comes in. Hitler failed in his attempt to destroy the R.A.F. largely because the engineers had provided England with a wealth of camouflaged, easily repaired and widely dispersed landing grounds. Owing to such decentralized targets the R.A.F. was able to keep its fighters almost continuously in the air. On the other hand, Crete furnishes an example of the disaster that may be caused by lack of aerodromes.

*Aerodromes for War.* By Major R. E. Smyser.

Aerodromes built for use under peace conditions must necessarily be laid out on different lines from those within reach of the enemy in war-time. Certain portions, such as runways, cannot be concealed from view from the air, but can, by suitable colouring, be rendered inconspicuous. The grouping of planes on the ground should be avoided. Individual aircraft should be parked round the perimeter of the landing area or in adjacent fields, in groups of about three planes, each plane at least 150 yards from the next, and no group closer than 200 yards to another at any point.

At field aerodromes, servicing facilities and closely grouped supply installations must be modified or eliminated. Petrol should be stored in underground tanks of about 25,000 gallons capacity. The tanks should be in pairs, pairs being not closer than 100 feet, with duplicate pipe connections. For small arms ammunition, chemicals and bombs, the order is dispersion and concealment.

The defensive arrangements and the scheme for camouflage are important items in the design of every aerodrome.

*Cement Dispersion.* By E. W. Scripture.

A new principle has recently been announced for the improvement of concrete and mortar: cement dispersion. When incorporated in an aqueous medium, the particles of a solid tend to agglomerate and act as large clumps rather than as individual particles. This is known as a flocculated condition. If a dispersing agent is incorporated in the solid-liquid system, then the clumps tend to break up, and the solid particles are distributed more or less evenly throughout the aqueous medium. The system is then said to be deflocculated or dispersed.

Until recently no dispersing agents have been known applicable to Portland Cement. Recent researches have, however, shown that certain complex organic compounds will disperse cement without any injurious effects.

Some of the effects of dispersion of the cement particles on plastic concrete or mortar are :—

1. More placeable concrete with less water.
2. Reduced shrinkage before hardening.
3. Greater economies.

On the hardened concrete the more important results of the dispersion are :—

1. Increased durability and longer life.
2. Increased watertightness.
3. Higher strength.

A.S.H.

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## *REVUE MILITAIRE SUISSE.*

(*August*, 1941.)—*Quelques réflexions sur l'arme blindée.* By Captain Schenk.

It is useless any longer for the Swiss to think that their country is unsuited to tank warfare.

For 1919, the Allies of the last war had planned 20,000 tanks to the Germans, 600. In 1940, 6,000 German tanks overwhelmed the 1,500 French; the British armoured division only came in at the end, when it was too late. This makes serious reading for the nation which was responsible for the birth of the tank.

The present war began with a French and a British doctrine of the tank as a supporter of infantry. With the Germans, the tank is a new independent arm, a spearhead for the infantry. It is launched at a great pace, and is supported by dive bombers which take the place of mobile artillery.

This article gives a rapid review of the employment of tanks and anti-tank defences in the different campaigns of the present war. In Poland, there was a full rehearsal of the German doctrine. The country lent itself to tank warfare, and the weather was fine. The rapid disorganization of the higher command and the disruption of communications at the very outset prevented any deployment of the means of anti-tank defence.

In Finland, the weather conditions hampered the use of tanks. Snow and frost upset the machines. But the defence was well armed against tanks, and the final Russian success was obtained by an infantry and artillery battle of the 1917 type.

In Norway, the chief feature was the failure of the defenders to destroy their approaches before the attackers gained possession of them.

In Holland and Belgium, the tactics of the Polish campaign were repeated, but with still more numerous tank forces. The linear defences were of no avail against an adversary who planned an absolute break-through.

In France, there were two different phases of operations: those of May, 1940, like those in Belgium and Holland, in which the armoured divisions, with their own resources, broke up a linear defence; and those of June, 1940, when, in spite of all their losses, the defenders put up a stiffer resistance to the armoured divisions, and caused the Germans to bring up their infantry and artillery. The final result was not affected; the Germans were too strong in men and weapons. The French were too wedded to the methods of 1918.

In Libya, the principal lessons to be drawn are: that the German doctrine is not a mysterious secret, and it can be copied by other armies; that the desert can be an anti-tank obstacle, and if men can overcome thirst, the tank certainly cannot.

In Albania, a winter campaign, mountainous country, wide use of demolitions, all the usual factors unfavourable to tanks were to be found.

In the Balkans, there was little opposition. The armed forces were totally inadequate to oppose the Germans.

In Russia, although it would be premature to draw conclusions from the operations so far, certain facts were already traceable. For the first time, there was appreciable equality between the opponents. The common notions of frontage, line, advance and rear were replaced by a zone of hostilities, proportional to the opposing masses. Although the tank and the car eat up distances, there is a "ceiling" which appears to be about 500 kilometres.

From this slight summary, the author draws these conclusions:—that the German doctrine has remained in principle the same after two years' fighting. In the event of a check, the Germans pass immediately to the classical infantry battle, the infantry arriving on the scene very rapidly. Against a linear defence, however powerfully organized, the break-through is always possible. On the other hand, if the defence has not become hypnotized by an arbitrary direction, if it is organized as a zone of resistance, consisting not of a forward and a rear position, but of a network of strong points facing in all directions, then the tank will find itself deprived of its normal and most profitable objectives. The losses will mount up and the moment will come when the tank attack cannot make further headway by itself, it must await the coming of other arms which will make a fresh break, and then the tank will resume its part.

For the Swiss Army, it is the defensive which interests it most. The author goes on to examine in some detail what measures the Swiss Army should adopt, with the lessons of the last two years in front of it.

The tactical offensive of the tanks to-day is everywhere the same : a smashing break-through, followed by a long-distance raid into the enemy's rear. These tactics are practically certain to succeed if the defence is merely linear. The most redoubtable adversary of the tank is the tank itself, if it is used solely as a mobile gun under armour.

The anti-tank defence depends upon the close co-ordination of three distinct elements : ground, weapons and works. The utilization of ground and its reinforcement by artificial barriers must be founded on a full knowledge of the tank, its characteristics and its way of fighting. The position of the obstacle is more important than its nature.

*Réflexions sur la Campagne de France (concluded).* By Captain E. Bauer.

This instalment deals with France's shortage of anti-tank weapons. The Germans broke through between Namur and Sedan with 7 armoured divisions, with 3,500 tanks. The French divisions, regular and reserve, were supposed to be provided with fifty-two 25-mm. anti-tank guns and six 47-mm. or 75-mm. guns in the divisional anti-tank company, or a total of 58 guns. The German infantry divisions, which were not subjected in France to tank attacks of any magnitude, because the tank divisions did most of the attacking, had 75 anti-tank guns. But only the divisions of General Billotte's group of armies were fully equipped, even on this inferior scale. The rest of the infantry divisions had only 36 anti-tank guns on the average. There were serious shortages also in anti-tank mines. The famous French artillery, pride of the French Army, was rarely used with full effect.

The French Army was doomed to failure.

*Commentaires sur la guerre actuelle.* The commentary this month is naturally confined to the operations on the Russian front up to the end of August. The Germans were still driving their deep wedges into the heart of Russia, but the Russians were fighting them behind the spear-heads of the tank divisions, fastening on the slower-moving infantry columns coming up on the roads, and taking heavy toll of them. Smolensk had been occupied and the Germans were intensifying their drive through the Ukraine towards the Caucasus.

(*September and October*, 1941, *not received.*)

(*November*, 1941.)—*La bataille des Alpes.* A French account of the fortnight's campaign (June 10th to 25th, 1940) by the Italians on the French Alpine frontier. This promises to be a more interesting account than that of Lt.-Col. Pederzoni on the Italian side, which appeared in this review during the Autumn of 1940. Italy made her treacherous attack at the moment when France was stricken down by Germany, and only a week before Pétain's appeal for an armistice.

The French, when war broke out in 1939, kept their Sixth Army (3 Corps or 11 infantry divisions) of about 500,000 men on that portion of the frontier from the Swiss border to the sea.

As Italy showed no signs of joining in with the aggressors, the French Commander-in-Chief gradually withdrew parts of this force to strengthen the armies of the north-east, until in May, 1941, General Olry had only 175,000 men left. These were the 14th and 15th Army Corps.

The region covered by this Army of the Alps was organized for defence in depth, consisting of zones or belts: the outpost position, watching the frontier passes, and consisting of a series of light works ; a position of resistance, containing much larger works of defence and obstacles ; and a rear position of similar character but consisting chiefly of blocked valleys.

The Italians had assembled a whole Army Group under the Prince of Piedmont, consisting of three Armies each of 2 Corps (=34 divisions). How eagerly the Italians must have awaited the order to attack the emaciated French forces opposite to them ! With Paris already in German hands, the French troops had little hope left, but they will not readily forgive the Italians their dastardly attack.

*La Guerre du Caucase.* By A.B. This article is written on the supposition that the Germans were about to drive straight on from the Ukraine into the Caucasus to capture the oilfields, and that Britain would be called upon to send aid to Russia there. The writer assumed that the Germans had indeed beaten the Russians, and that the invasion of Caucasia would throw them back behind the Ural mountains, where no main lines of supply except the Trans-Siberian railway would be left to bring in help from England and America. The advantages were going to be all with Germany ; Russia was already unable to renew the offensive. Fortunately, the tide has turned, and Hitler seems further than ever from his coveted prize, the oilfields.

*Commentaire sur la Guerre Actuelle. La Guerre de mines.* This month's commentary is confined to land mines, anti-tank mines and booby traps. The writer remarks that the slow methods of mine warfare of the last war, requiring months of patient preparation to achieve one crater, have given place to whole regions of surface mines and traps for delaying the enemy and making every step a risky one. Since there is no stabilized line anywhere, this is a natural development. Every sort of device is being employed on the Russian front. The German pioneers are kept busy picking up the thickly-strewn mines, and now that the battle is surging in the reverse direction, they are doubtless equally busy laying them.

The devices described are the familiar ones of the last war.

W.H.K.

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## *JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA.*

(*July*, 1941.)—This number was not received in England until late in November, and so the Editorial is perforce considerably out of date.

Pride of place must be given to *A Brigade at Dunkirk—and after*, by Brig. J. G. Smyth, V.C., M.C., who took over command of a Territorial brigade in the North of England in January, 1940. After receiving orders first for France, and then for Norway, the brigade finally reached the Franco-Belgian frontier in April. Very soon after came the German attack on the Low Countries, and the brigade, now expanded into a brigade group, moved up to the Escaut, then to a position along the Scarpe, then to Lille and finally to Dunkirk; 22 days and nights of almost incessant marching, always impeded by refugees, and punctuated by constant air attacks and occasional scraps. The R.E. are specially mentioned for the excellence of their bridge demolitions. The narrative needs to be carefully followed on a map; unfortunately the *Journal* provided none. The whole story is of exceptional interest.

Auspex, in *Combined Operations by Sea, Land and Air*, reminds us that in future major wars officers will have to bear in mind the problems of all three services.

*Wheels over Eritrea* by Lieut.-Col. Webb, tells of the advance into that country from the Sudan. Place-names, and those of units are omitted for fear of the blue pencil, but if one may hazard an easy guess it is the tale of part of the force which advanced from Kassala to Keren. At 10.00 hours one day they were preparing for an attack next day; then the enemy vacated his position, and by next morning the brigade was over the border in pursuit. The enemy was given no rest, and the brigade group accounted for an immense amount of the enemy and his material with negligible loss to themselves. The engineers are mentioned as contributing with army track to the crossing of many dry river beds and so facilitating the amazing mobility of the force.

*Drawing the Moral* comments on our national proclivity, in assessing the lessons of a campaign, to judge by results only rather than by the causes of such results—what the author styles headline thinking.

*An Open Letter to young Squadron and Company Commanders* is an apt comparison between football and fighting. In both you study your opponent, his strong and weak points, his capabilities for team work and so on. We have a great superiority over our opposite numbers in the German army, says the author, in that we play games while he does not.

*Old Army Recruiting Posters* gives some amusing examples of attempts to catch recruits a century or so ago. One in particular promised the young soldier that he would return from service with "Manners, money and experience."

*Thoughts on propaganda* presses for more and better stuff, remarking that the official text-books are mute on the subject.

*Norperforce* consists of amusing yarns about the show in N.W. Iran in 1921.

*Salient and Somme* is a description of a tour to those battlefields in April, 1939, by four officers who fight their battles o'er again, and note with dismay that the Maginot line does not extend along the whole of the Franco-Belgian frontier. (It is understood that this omission was due to Belgian susceptibilities.)

*Is Federal Union possible?* asks the question, but does not provide an answer. It is a succinct account of the ideal aimed at by the Federal Union, but those who remember the brilliant hopes with which the League of Nations started will fight rather shy of answering the question in the affirmative.

There are some photos, and a brief description of *Armoured Vehicles* and a gun-carrying truck for the South Waziristan Scouts. For lack of bullet proof plate, two layers of mild steel plate with a 2-in. air space between them have been used, and found to be proof against .303 at point blank range, with a slight denting only of the inner plate.

*A Sidelight on Recruiting* is a description of the method in use in the I.A., since 1932; it seems to have proved useful during the present war.

*Your Home when you retire* is sound advice by which nearly every officer in the Army may benefit; while *Crocodile Shooting* is rightly praised as giving very good practice in stalking.

F.C.M.

## ARMY EDUCATION.

(*December*, 1941.)—The Master of Balliol in *Education after the War*, considers how two of the great peace-time evils of our Social system, unemployment and class distinctions, can be cured by a properly planned educational system.

It is to be hoped that there will be a corresponding planning in the Economic sphere to remedy past mistakes in production and distribution, so that the nation of skilled workers which he plans to produce will find suitable and regular work.

The writer advocates State control of the Education of all young people up to the age of eighteen, particularly of those who go into industry before reaching that age; and insists that these shall only be allowed to do so for their training and not merely to go into "blind alley jobs."

Attention is drawn to the evils of the present system whereby there is one system of education for the poor and another for the rich, and a suggestion is made that our Public Schools should be made available to those who can best profit from their special type of education, and not only to those who can pay the fees; just how this can be worked out in practice is a serious problem in itself.

In considering Class distinction The Master of Balliol points to the necessity for adult education, to train the people to understand things that are common to us all, as an important offset to the specialist outlook that modern conditions engender.

He suggests that, in the Forces, people, previously in different social divisions, will be able to discuss what we all hope for in social reconstruction and, finding that there is so much common ground, will lay the foundations of a positive adult education which will make us a far finer nation than we have ever been.

*The Wider Vision*, by Oliver Bell, shows that films as an instrument of Education, like all instruments for whatever purpose, call for careful study if the best is to be got out of them.

*The Work of the A.E.C. in Hospitals* is a most interesting article in which Captain H. L. Hunter shows how widespread are the activities of the A.E.C., and suggests that there is still much that should be done.

In *Broadcasting and Army Education* there are many useful suggestions for making better use of the facilities available, but Mr. Gibson makes it clear that the provision of wireless sets falls far short of the needs.

A word must be added about the Advertisements, as, besides the semi-comic ones dealing with cleaning materials, such as "For Duty or a Date," there are many which offer suggestions of great value to both Students and Instructors.

A.R.A.I.

## THE INDIAN FORESTER.

(*September*, 1941.)—The summary of revenue and expenditure in the Forest Department for 1939–40 shows a net surplus in all India, excluding Indian States, of Rs. 75 lakhs approximately. There is a surplus in every province: it is rare that one or more does not show a deficit, even if slight.

Erosion, as ever, forms a main topic; one of the causes thereof in the Yomas in Eastern Burma is given as the series of earthquakes in 1930, which started landslips, latterly much aggravated by the rainfall.

An item of interest is a statement of wild animals shot in certain provinces and states in 1939–40; thus the U.P. accounted for 110 tigers; Burma for 629 wild elephants. Some sportsmen must be very meticulous in their returns, as we read of one fishing cat in Bengal and one jackal in Behar.

Efforts are being made by Government to impart instruction in afforestation to tribes on the N.W. Frontier. Thus Malakand has a protected area of 394 acres. The Afghan Government now allows logs felled in Chitral to be floated into British India by the Kunar and Kabul rivers. Negotiations for the afforestation of an area near Razmak broke down because the tribesmen demanded such a vast sum by way of compensation that it amounted practically to blackmail.

(*October*, 1941.)—*Headwater Highways*, an extract from an American paper, describes such roads as a new forest menace. Engineers are apt, for obvious reasons, to align roads as near to watersheds as ruling conditions allow. They seldom contemplate the damage that may thereby result to the forested areas which they may have to traverse. Drainage is often interfered with: erosion or landslips may be started: the felling of a belt of trees generally exposes unfelled neighbours to the effect of wind which their previous sheltered position rendered them little able to resist. The article conveys the lesson that the engineer should invariably consult the forester should he be about to align a road in or near a sylvan neighbourhood.

The Inspector General of Forests has recently visited Baluchistan, where at present only .6% of the area of the province is reserved forest. He considers that a great deal more might be done to encourage siviculture. The splendid juniper forests round Ziarat are testimony to what might be done in many parts; there were also considerable forest areas near Quetta, Loralai and Fort Sandeman, which have disappeared during the last fifty years.

F.C.M.

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## *AN COSANTÓIR.*

In January, 1942, *An Cosantóir* appears in a new form with a brilliant cover and has been adopted by the Publicity Section of the Department of Defence, Parkgate, Dublin. The Journal has many attractive features and is full of instruction for all branches of the service. Its reproductions of articles in American Journals and especially translations of German articles taken from the *Command and General Staff School Military Review*, U.S.A., are well chosen.

As an example, the present number contains a description of the crossing of the Somme at Picquigny by the 63rd German Infantry and tells how they fought their way through a marsh and drove the French from the hills beyond. A heavy bombardment permitted the material for the crossing to be brought up and all preparations to be made without interference. A company of engineers attached to the regiment constructed two ferries and a footbridge of Kapok bags, and more important bridges were constructed subsequently. There are also two articles reproduced from the *American Field Artillery Journal*, "Experiences of a Dutch Artillery Detachment" and "The Capture of Crete," in the latter of which it is impressed that the most important lesson is the re-emphasis of the fact that to ensure the success of any operation adequate air strength must be assigned and placed at the disposal of the commander on the ground. The importance of Information is stressed by Major J. M. MacCarthy of the G.H.Q. in a short article entitled "No News is Bad News," and there are articles on "Discipline and Training" and "The Importance of Physical Fitness," "The Burning of the Dublin Custom House," on May 25th, 1921. "A Graphic Account of an Historic Exploit," is described by Commandant M. O'Kelly of the Infantry Corps. Only one of the articles is in Erse.

F.E.G.S.

# CORRESPONDENCE.

## R.E. CHINESE JUBILEE CELEBRATIONS.

The Editor, *The Royal Engineers Journal.*

SIR,

I have been greatly interested by reading the article on the " Royal Engineers Chinese Jubilee Celebrations" which appeared in the December number of *The Royal Engineers Journal*, for on the 8th April, 1888, I took over the command of the Hong Kong Company, R.E. from Lieutenant (now Brig.-General Sir James) Edmonds and he and I are, I think, the only surviving officers of that company before Chinese were enlisted in it.

At that time, the Company consisted of two parts, each approximately 50 strong, one part consisting of ordinary R.E. personnel, and the other part of civilian Chinese. These latter were administered by Cheon Peng Sow (he was a Chinese, not a Manchu) who filled any vacancy that might occur and kept discipline by a system of small fines. They were an exceedingly efficient and well-behaved body of men and I cannot remember ever having the slightest difficulty with them during the three years I was in command. The severest punishment, other than discharge, was the burning of a paper dollar from the man's pay at a specially lighted candle, a careful record being kept of the number of the note for the Hong Kong and Shanghai Bank.

About half these Chinese were boatmen employed chiefly on the *Solent* and *Miner* and were (*pace* Captain Cartwright-Taylor) always Pun-ti from the junk and sampan population of Canton and the Pearl River. The remainder, who were employed on connecting-up and similar Submarine Mining duties, were Hakkas, mostly from around Swatow. They were exceedingly good at their work and it was by no means unusual to see a British sapper shown how to splice a cable or to make a joint by one of the Chinese. They were all very strong physically and, with their bamboo carrying-poles, moved the mines, sinkers, etc., in a way no European could equal.

This physical strength was very apparent during the annual S.M. Practice, which lasted for two months, for it was then necessary to supplement them by coolies hired in the local market. These were usually a very poor lot, under-nourished and of little use except for carrying weights and it always took at least four of them to do the work of two of our own splendid men.

Most, if not all, of them were fine swimmers. In the summer of 1889, I was asked by the Hong Kong Government to try to increase the depth of water over the dangerous Bokhara Rock near the entrance to the Ly-mun Pass. I had some very good divers in the Company, in particular my Company Serjt.-Major Lyons and, with their aid, we hung a necklace of about 1,000 lbs. of guncotton round the top of the rock. The charge was fired from the *Solent* and immediately the surface of the water all around was covered with fish of lovely colours, some dead and some only stunned. This was too much for my Chinese, who all dived overboard to collect them. I thought I should never see many of them again, so I jumped into the *Solent's* dinghy with Lce.-Corporal Hawkins and spent an anxious half-hour picking up men and fish.

In those days, the Hong Kong Company formed part of a strange organization called the Eastern Battalion, R.E. which had four companies, one in Mauritius, one in Trincomalee, one in Singapore and one in Hong Kong. Their first C.O. was Major Whitmore, R.E. whose Head Quarters were at Singapore. He was also the last, for, when his term of appointment came to an end, the Battalion ceased to exist, as it was obviously impossible to administer such widely dispersed companies as one unit.

When I first went to Hong Kong, I was the only officer with the Company, but the S.M. Defence was under a D.O.S.M., Captain H. P. Knight, and, in 1889, I was joined by Lieut. E. G. Young, R.E., who died of enteric in South Africa during the war in 1900.

I handed over my Command to Captain Dumbleton in February, 1891, just six months before the Chinese were enlisted and one of the few things I had to do with that eminently desirable object was to submit a design for their uniform based on that then worn by the Chinese Army. I don't know if it was ever adopted, probably not.

I think the three years I was with the Hong Kong Company were among the happiest I have spent since I joined at the Shop nearly 60 years ago and I have the most pleasant recollection of many of the N.C.O's and men whom I had the honour to command, such as Darby, Lyons, Stevens, Ramage, Dredge, Amor, Redding, Squires, Ruse, Bone and many others. I hope that some of them are still in the land of the living and have as happy memories of our old Company as I have.

Yours faithfully,

G. M. W. MACDONOGH.

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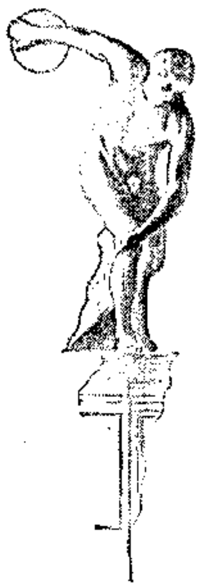
## *ERRATA:*

The following corrections should be made in *The R.E. Journal* for December, 1941:—

PAGE 423. The Footnote should read, "*Folding Boat Equipment."

PAGE 519. Line 3 should read "(Basil Blackwell, Oxford.)"

*By Appointment*
*Silversmiths to H.M. The King*



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