THE ROYAL ENGINEERS JOURNAL—JUNE 1959

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THE ROYAL ENGINEERS JOURNAL

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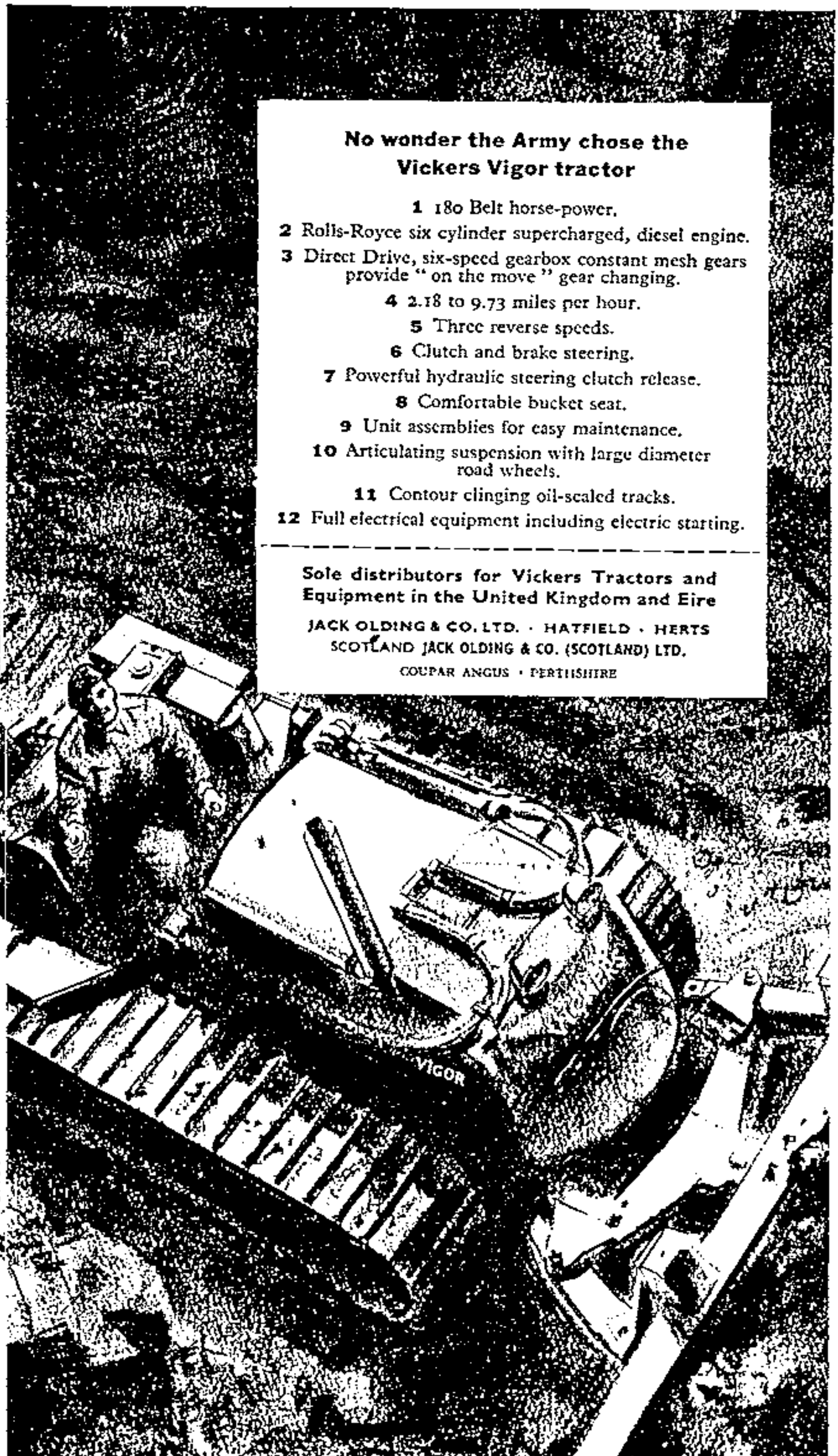
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Statues At Khartoum

Statues of Kitchener and Gordon Recently Repatriated from Khartoum

by

The Editor

EARLY in the morning of 1 April last two large packing cases, measuring 16 × 17 × 6 ft. and 14 × 11 × 6 ft. and weighing 5½ tons and just over 15 tons respectively, were placed ashore at Chatham Dockyard. The larger, but lighter case contained an equestrian statue of Field Marshal the Earl Kitchener of Khartoum and of the Vaal and Aspall, KG, KP, PC, GCB, OM, GCSI, GCMG, GCIE, former Colonel Commandant Royal Engineers. The smaller, but heavier case held a statue of Major General C. G. Gordon, CB, late Royal Engineers, mounted on a camel. Both statues had been repatriated from Khartoum. The statue of Gordon was destined for the Gordon Boys' School, Woking. The statue of Kitchener was to be taken over by the Royal Engineers.

That a crate containing a statue of a Field Marshal mounted on a charger should be far larger than one holding a Major-General astride a camel was beyond the comprehension of the Dockyard Stores Department, and it was only after considerable persuasion that each statue was consigned to its rightful future owner.

The reason for disparity in dimensions is easily explained. Whereas the statue of Gordon is life-size that of Kitchener is one and a half times reality. The plumes of the latter's cocked hat flutter 14 ft. 6 in. above his horse's hoofs. The horse itself measures 16 ft. from its distended nostrils to the tip of its flowing tail. The reason for the disparity in specific gravity is also simple. The statue of Gordon is solid: that of Kitchener hollow.

Neither of the two statues are originals and a short history of them may be of general interest since there have been several inaccurate stories printed about them both recently.

During the tour of the Middle East in 1911 Lord Kitchener visited Khartoum as guest of the then Governor-General, Sir Reginald Wingate, who suggested that the Soudan ought to possess a monument to him. Kitchener suggested a replica of a bronze equestrian statue of himself recently produced by the sculptor Mr. Sydney March for erection on the Maidan in Calcutta. An estimate for this replica, however, amounted to a sum well beyond that which the Soudan Government could afford. Nothing daunted Sir Reginald Wingate told the London firm who cast the original statue that, to reduce the cost, he could send them several tons of ingots of waste brass, made from empty cartridge cases collected from the battlefield of Omdurman where in 1898 Kitchener finally avenged Gordon's murder.

This brass, if mixed with tin, would form a suitable bronze. The firm generously offered to accept the ingots and cast the statue without charge. Owing, however, to difficulties arising from the 1914–1918 War the statue did not arrive at Port Soudan until 4 November 1920. After its arrival at Khartoum, the Civil Secretary's Office was informed in the normal way that a "parcel" had been received for the Department and an orderly was sent on a bicycle to collect it. The parcel which confronted the astonished orderly was the enormous crated statue. The statue was erected in 1921. A reproduction of a photograph, kindly lent by Mr. H. S. Job, CBE who was stationed in Khartoum at the time, showing the final stages of the erection of the statue on its plinth illustrates this article. The method used would have delighted the pre-war Field Works School.

A site at the south-west entrance to Kitchener Barracks, Chatham, has been selected for the re-erection of the statue. Mr. Sydney March, the sculptor of the original statue, is to advise on the design of the new plinth. It is a splendid site and the statue will stand in full public view. No doubt modern mechanical aids will be used this time to erect the statue.

A photograph of the Gordon statue, as it was in Khartoum, also illustrates this article. The original is well known to all Sapper Officers. It stands outside the Main Building of the School of Military Engineering, Chatham. The inscription is simple but impressive. On the base of the statue there is one word "*Gordon*." On the plinth:

Charles George Gordon
Royal Engineers
Companion of the Bath
Major General in the British Army
Mandarin of China
Pasha of Turkey
Governor General of the Soudan
Born at Woolwich 28 Jan. 1833
Killed at Khartoum 26 Jan. 1885
Erected by the
Corps of Royal Engineers
1890

The sculptor of the statue was Mr E. Onslow Ford, RA who exhibited it in the Summer Exhibition of the Royal Academy of 1889. The statue caused considerable comment. A national military hero mounted on a camel was an innovation; such personages were until then usually depicted on horseback.

The statue was unveiled at Chatham on 19 May 1890 by HRH The Prince of Wales, afterwards King Edward VII, accompanied by the Field Marshal Commander-in-Chief the Duke of Cambridge, at that time Colonel-in-Chief of the Corps, and Members of the Army Council. A Guard of Honour found by the Hampshire Regiment was mounted at Chatham station for the Royal Party which arrived by train. The Party was escorted to Brompton Barracks by a Squadron of the Royal West Kent Yeomanry where it was received by a Royal Engineer Guard of Honour.

At the time of the unveiling neither the South African War Memorial Arch, nor the Kitchener and the 1914–18 and 1939–45 War Memorial Obelisk existed and Gordon's statue had an uninterrupted view of the

Crimean Memorial Arch, Gordon himself took a distinguished part in the siege of Sebastopol, and Brompton Barracks, well known to Gordon when he was Adjutant Royal Engineers and Instructor in Field Fortifications. On parade for the unveiling ceremony were the Service Battalion (forerunner of the Depot Battalion) the Submarine Mining Battalion and the Training Battalion Royal Engineers and Sapper detachments from Aldershot and Southampton, a Royal Naval Brigade from Her Majesty's ships at Chatham and infantry pioneer classes undergoing instruction at the SME representing nearly every Infantry Regiment at that time stationed at home. In attendance also were boys from the Training Ship *Arethusa*, in which Gordon had taken a lively personal interest, and from the Gordon Boys' Homes.

The statue of Gordon, recently repatriated from the Soudan, is a replica of our statue, produced from the original cast. It was erected in July 1902 in London on the site now occupied by the statue of Nurse Cavell. Due to the instigation of Lord Kitchener and Lord Glenesh of the *Morning Post* it was, however, decided to move the statue to Khartoum. In November 1902 it was shipped in the SS *Cedardine* which unfortunately was involved in a collision and sank in the Thames. After twenty-four hours submersion in the river the statue was salved and loaded into another ship bound for Egypt. After a long and adventurous journey by rail and river from Alexandria, including another ducking in the Nile, the statue arrived at Khartoum. Its adventures were, however, not quite over. Shortly after its erection in 1903 the plinth subsided —someone had not fully taken into account that 15 tons of statue when calculating the foundations. This was, however, soon put right, and the statue remained a landmark in Khartoum until last December when, fifty-five years after its erection and seventy-three years after Gordon's death, the statue, and that of Kitchener, were covered by canvas shrouds and lowered from their pedestals to begin their long journey home.

The Gillois Assault Crossing Equipment

By MAJOR G. H. McCUTCHEON, RE

(Note: The Author wishes to acknowledge the help given him by Lieut.-Colonel Gillois in preparing this article and providing the illustrations.)

IT was obvious, even before the dust had settled on Hiroshima, that the advent of the atom bomb was the greatest single advance in the science of war. Greater even than the invention of gunpowder. It was obvious also, though, for want of tactical nuclear weapons, not so quickly appreciated, that although tactics and strategy had been out-dated, there were still two golden rules for the soldier or army which hoped to survive. The first was to keep moving; the second, to present the smallest possible target to the enemy.

Amongst those most deeply impressed by the military lessons of Hiroshima was the then Captain Gillois of the French Engineers. Earlier, in 1944, while a bridging instructor in North Africa he had begun to give much thought to the problem of improving on the existing assault equipment. As Gillois saw it after Hiroshima, the transformation of tactics was so radical that, to give the field army a reasonable chance of survival, an equally radical change must be wrought in assault bridging and water-crossing techniques. It seemed to him that no logical development of the equipment available in 1945 gave any promise of providing the answer. There were always too many men, too many vehicles, too much equipment involved on any crossing site for too long.

There was another equally important objection to developing 1945 equipment. There was now a requirement for bridging that could be removed, broken or dispersed as speedily as it had been constructed. If this particular requirement could not be met then, assuredly, the crossing would become a target and tactical surprise—and the bridge!—would be lost.

There were other considerations. The equipment must be capable of moving across country as well as on surfaced roads. It must be capable of keeping up with a mobile force without adding greatly to the size of the column it supported. It must be simple to construct, hard-wearing and easy to maintain. There must be a high degree of uniformity throughout the full range of equipment. The numbers of men required to construct and operate the equipment must be kept to a minimum.

The specification which Gillois set himself to meet was, in fact, almost as exacting as it was possible to conceive. It could only have been surpassed had he also burdened himself with a requirement that it should all be done more cheaply than it had ever been done before! But the Colonel was a practical man. He recognized from the start that the specification he had set himself to meet could not be met cheaply. He refused, nevertheless, to be frightened by costs and, in due course, having run short of cash when in sight of his goal, he sank his own money in the project. Greater faith hath no man than this!

Colonel Gillois first started practical work on his project in 1945 at Rastatt in the French Zone of Germany. He was then a Captain on the staff of the French Engineer Centre. Money, materials and equipment were scarce at first but not so scarce as in France itself. Gillois, however, worked on against considerable odds until in October 1955 he had succeeded in producing the prototype of what was to be the basic unit of his new range of assault bridging equipment.

It was during the earlier stages of development that Dr. Gehlen of the firm Eisenwerke Kaiserslautern (EWK) came into the project. Gehlen had originally met Gillois while engaged in clearing the wrecked Rhine bridges and, himself an engineer, at once saw the possibilities of the equipment. From then on EWK and Dr. Gehlen have taken an important part in all the development work and provided much of the financial backing.

The full range of equipment is now available from production and comprises four variants of the one basic unit. This unit, essentially, is a watertight alloy pontoon mounted on a four by four chassis, the two axles of which are retractable. The prime-mover is a 6-cylinder Kaelble diesel of 225 h.p., soon to be 275 h.p. and multi-fuel. This unit provides power also for the hydraulic system as well as high and low-pressure air compressors; it also operates a winch for recovery and anchorage. The steering is power-assisted and the 500-litre tank gives a range on hard roads of some 320 kilometres.

The hull which measures, approximately, $36 \times 10 \times 9$ ft. high, in addition to providing comfortable positions for the driver and signaller, provides sleeping accommodation also for the crew of four on bunks which fold down from the side bulkheads.

The following four variants of the basic unit go to make up the full range of equipment.

THE DECK UNIT

This is the version designed to make up rafts and bridges. Each deck unit provides 8 metres of decking, 4 metres wide, which is normally stowed along the length of the pontoon and swung hydraulically through 90 deg. before being connected into bridge. The decking itself is divided, longitudinally, into three sections. The centre third is normally stowed on top of the others and lowered hydraulically into position as the outside thirds move laterally to their final positions.

Additional buoyancy is provided by two eight-compartment buoyancy cylinders fixed along either side. These are hung from brackets which hinge out from the sides and are inflated from within the pontoon by a high-pressure air compressor. The rigging and inflating of these cylinders take up most of the forty minutes which are spent in preparing each of the water-crossing units. All the preparation is done by the crew of four. When afloat the deck unit is powered through a propeller unit which is lowered into position hydraulically.

THE RAMP UNIT

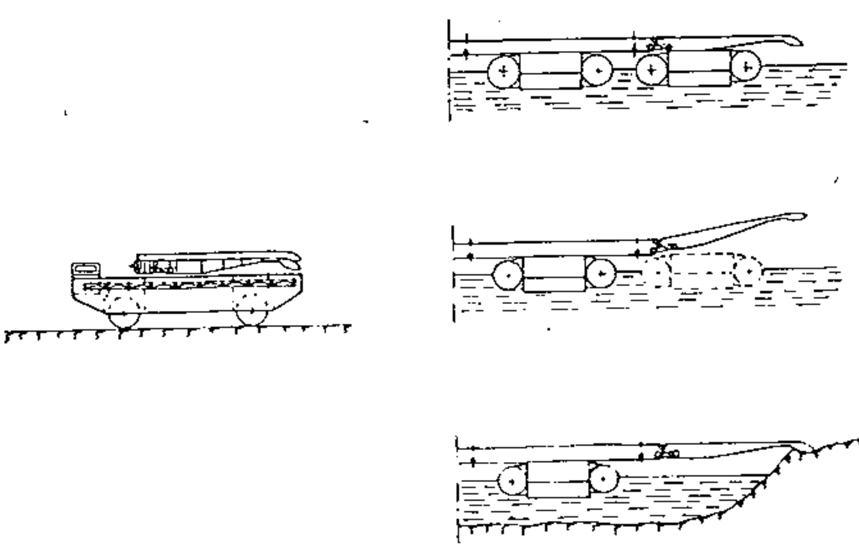


Fig. 1.—The ramp is connected to the end floating bay and the basic unit freed.

This version provides an 8-metre-long ramp which, when connected to the end floating unit, is lifted hydraulically so that the pontoon upon which it is mounted can be driven out as a tug to assist in forming bridge or to act as a safety boat. The pontoon in this version has a shaped bow to improve its performance in water. Power is provided, as in the deck unit, through a propeller.

Photo 1.—The Deck unit before rigging.

Photo 2.—The Deck unit ready for launching.

The Gillois Assault Crossing Equipment 1,2

The Amphibious Ferry—"Le Bac"

This was originally conceived to meet conditions in Indo-China. In this version the basic unit is fitted with an alloy deck and a bow-loading ramp hydraulically operated. The end of the ramp is reinforced and fitted with spikes on the underside to improve its grip.

The Assault Bridge

The version is designed for the bridging of short gaps of up to 25 metres. The basic unit is fitted with a double-folding rear ramp, 5.5 metres long, and a similar ramp of 15 metres at the bow. The deck of the pontoon is reinforced and forms part of the bridge. The single unit has a capacity of Class 25 and can be rigged in about 9 min. Given two positioned alongside one another a Class 50 crossing can be provided with almost equal speed. Development is now in progress to reduce the rigging time to 4 min. The assault bridge unit can float but is not fitted for rigging with buoyancy cylinders.

All four of these types were demonstrated by French Engineers in November last at Rastatt. It was impossible, in so short a time, fully to appreciate either the limitations or merits of the equipment. Enough was seen of it, however, to suggest that, exacting as had been his specification, the infectiously enthusiastic Colonel Gillois had succeeded in meeting it to an impressive degree. The following notes, it is thought, will bear witness.

Speed of Construction

A 250-ft. Class 50 bridge was completed in 27 min. from the appearance of the first unit on the river bank some 400 yds. downstream of the site. The weather at the time was bitterly cold and the troops were not obviously well drilled. Two other points which were most noticeable were the remarkable quietness of the slow running diesel engines and the total absence of anyone dashing about. To illustrate further the significance of this most impressive demonstration the following Table shows the estimated construction times for a selection of rafts and ferries comparable in capacity with current British equipment.

TABLE "A"

Type	Class	Working Party	Construction time on site
Raft	70/80	24	10 min.
Raft	30	16	10 min.
Ferry	20	4	2 min.

Note:

Although the times achieved by the new British bridging equipments are very much better than those that were obtained in World War II, they are still substantially slower than those shown above.

Speed of Dispersal

This was most impressively demonstrated when the 250-ft. bridge was broken and the basic units driven out of the river in little more than 15 min. The slope of the bank was about 1 : 3 and the surface soft. No other aids were used apart from a widely-meshed track of light channels approximately 36×6 in. This was laid in a matter of moments while the bridge was being broken.

Photo 3.—The Deck unit afloat with the decking swung into the line of bridge.

Photo 4.—The Ramp unit ready for launching.

The Gillois Assault Crossing Equipment 3,4

Photo 5.—The Amphibious ferry being launched over a 5-ft. bank.

Photo 6.—"Le Bac" afloat.

The Gillois Assault Crossing Equipment 5,6

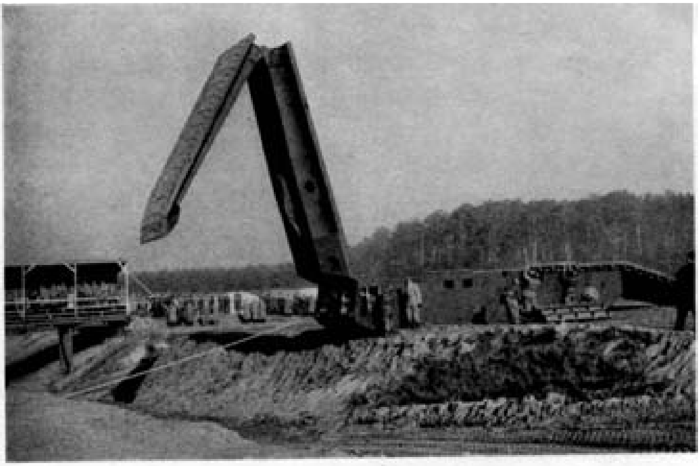


Photo. 7.—The Assault Bridge. Unfolding the front ramp. Note that the wheels have been retracted.

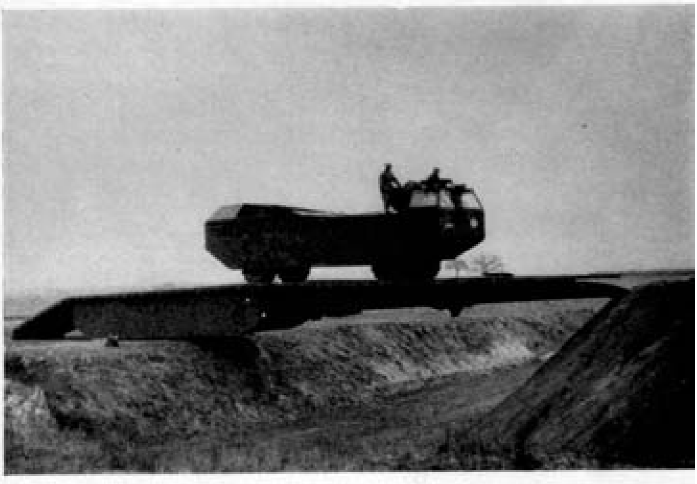


Photo 8.—"Le Bac" crossing the Assault Bridge.

The Gillois Assault Crossing Equipment 7,8

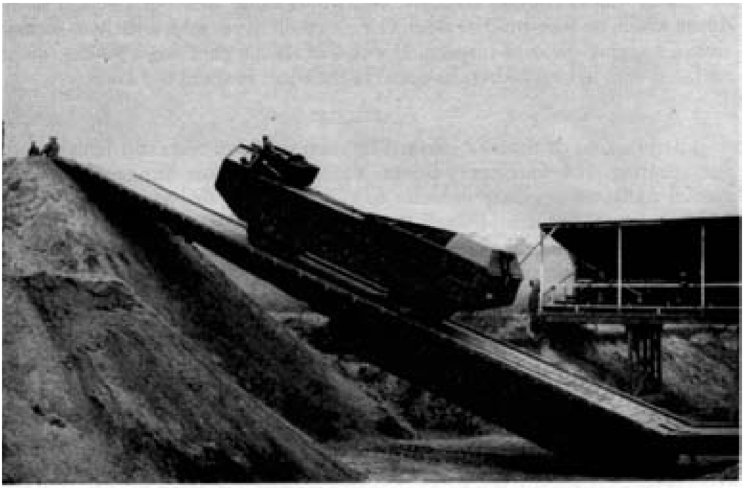


Photo 9.—"Le Bac" climbing a 35-deg. slope over the Assault Bridge.

Photo 10.—A Patton tank on a Class 30 raft. The raft commander is standing on the tank turret.

The Gillois Assault Crossing Equipment 9,10

MOBILITY

The equipment was demonstrated to show a road speed of just under 40 m.p.h. Across country it moved easily over fairly firm but steepish sand-dunes which no four-by-four 3-ton vehicle could have tackled without serious risk of bogging or over-turning. It was also shown climbing a 50-deg. slope surfaced with light tracking. Its speed in the water is about 6–7 knots.

SIMPLICITY

The junction of units is effected by marrying two male and female ends and securing with four heavy hooks. There are no loose bits to get lost, no special tools, no ancillary vehicles to clog a bridge site and give away its location, no truck loads of small stores to be sorted, guarded and accounted for! No specialist training is required beyond what is necessary to rig the buoyancy gear and operate the hydraulic system.

RELIABILITY

Very considerable claims were made as evidence of the reliability of the different units. No accurate appreciation can be made, of course, without extensive troop trials but, certainly, there were no breakdowns of either prime-movers of hydraulic systems during the demonstration at Rastatt. It must anyhow be the case that the uniformity of the equipment greatly simplifies the problem of maintenance as well as the provision of spares.

ECONOMY OF MANPOWER

The 250-ft. bridge was built by forty men. To illustrate the full measure of the transformation brought about by this equipment, however, one must compare the bridging of the Rhine at Xanten in 1945 with Bailey pontoon and nowadays with Gillois. In 1945 six field companies, three field parks and a bridge column were directly involved in bridging the river in 48 hours. It could nowadays be done with Gillois equipment using 256 men and sixty-four vehicles in one-sixteenth of that time.

Given so many military virtues, it would not have been unexpected had the resultant costs been vicious. At first sight a price of some £50,000 for each unit may seem so. To get a better perspective, however, it should be remembered that costs of conventional equipment do not include the cost of vehicles, special trailers, cranes or recovery vehicles. Neither do they take account of so considerable an item as the maintenance costs of the bridge column whose only function is to move the equipment. Taking it all in all then, and having regard particularly to the remarkable saving in manpower, the cost—which is less than that of a Centurion—should be regarded as being far from prohibitive. A near-perfect solution to any military equipment problem will always be expensive in terms of money only.

Although nominally Class 50, the assault pontoon bridge has very recently been tested using both a Centurion and a Conqueror with an Astec and semi-trailer. Both tests proved the bridge safe for each type of tank, mounted and dismounted. As it has also been tested with the 280 mm. gun, it is now apparent that the true classification is probably Class 80. It is certainly the case that the bridge will take all NATO loads. These trials were of great interest also in further emphasizing the many military virtues which this bridge possesses. The test bridge of 200 ft. was completed in 13 min.—a record—and the Centurion tank driven across it at 20 m.p.h.

Little is known yet of the tactical handling of the Gillois equipment. What is obvious is that it should be entirely in engineer hands and in no way an element of the bridge column. It will be argued, of course, that any single-purpose field unit is unsound in principle. In a battle of manoeuvre and deception, however, such a bridge unit supporting, say, a brigade group which is supplied by air, might be called upon to form and break bridge several times a day. It would also be expected to march with the brigade column. It is this very requirement, and its capacity to meet it, which would seem in every way to justify the inclusion of such single-purpose units in the orbit of any army whose chances of survival are directly proportioned to its mobility.

The size of an assault bridge squadron and the scale of equipment it should have are not easy to estimate. Much would depend on the theatre in which they were required to operate. The establishment which is outlined at Appendix "A" (Page 129), for example, is one designed to meet conditions in North-West Europe. Given equipment on this scale and a strength of much less than 200 men, the following are amongst the permutations which could be built and manned at any one time: four × Class 20 ferries ("Le Bac") and one ×450 ft. Class 50 bridge; or two×250 ft. Class 50 bridges; or one×300 ft. Class 50 bridge, two × Class 30 rafts, one × Class 70/80 raft.

The assault bridge itself has not been included in the establishment as it would seem to fit more naturally into an armoured engineer unit.

From what has been seen of it there is little doubt that the range of assault bridging produced by the Colonel and EWK has, in almost every way, met the specification which Gillois set himself. He has indeed wrought that radical change which he set out to do. It is the very measure of his success, however, which makes it difficult to assess its full tactical significance. What is apparent is that his assault pontoon bridge has out-dated all other current types as certainly as the jet out-dated the piston engine. The current British assault bridges, like the piston engine, still have their vital functions but the Gillois equipment has transformed the problem of crossing a water-gap in such measure as almost to hush the cry for amphibians of all kinds and at all costs. If this should prove to be the case then it will have justified itself on the grounds of cost alone.

Editorial Note:

Official action is in hand to have this equipment tested and evaluated in the UK.

APPENDIX A

Establishment for an Assault Bridge Squadron

(i) Personnel

Detail	Sqn. HQ	Each Tp. (Two Tps.)	Total
OC (Major)	1	—	1
2 IC (Capt.)	1	—	1
Tp. Comd. (Capt.)	—	1	2
Subalterns	1	—	1
Total, Officers	3	1	5
SSM (WO II)	1	—	1
SQMS	1	—	1
S/Sgts.	—	1	2
S/Sgts. VM	1	1	3
Sgts.	—	1	2
Sgt. Clerk GD	1	—	1
Sgt. Sigs. NCO	1	—	1
Total, WO's, S/Sgts. and Sgts.	5	3	11
Cpls.	2	8	18
L/Cpls.	4	13	30
Sprs.	16	49	114
Total, Rank and File	22	70	162
Total, Other Ranks	27	73	173
Total, All Ranks	30	74	178
Attached			
R Sigs., Sgt. Radio Mech.	1	—	1
RAPC Clerk, Sgt.	1	—	1
ACC Sgt.	1	—	1
Cpls.	2	—	2
Ptes.	5	—	5
Total, Attached	10	—	10
Total, Assault Bridge Squadron	40	74	188

(ii) Distribution of Rank and File by Trades

Detail	Sqn. HQ	Each Tp.	Total
Clerks GD	2	—	2
Craft Operators	—	14	28
Drivers	9	19	47
Driver Ops.	1	1	3
Electricians RE	—	1	2
Engine Fitters, IC and P	1	2	5
Field Engineers	1	18	37
Plant Operators (T.)	1	—	1
Sheet Metal Workers	2	—	2
Signallers RE	—	11	22
Storemen Tech.	1	1	3
Storemen	2	1	4
Vehicle Mechanics	1	2	5
Welders	1	—	1
Totals	22	70	162

(iii) Transport			
Trucks			
¾-ton GS, LWB	2	1	4
1-ton GS Cargo	1	3	7
3-ton GS Cargo	1	1	3
Binned	1	—	1
Office	1	—	1
Bowser	2	—	2
Trailers			
½-ton	2	1	4
1-ton	1	1	3
Water	1	1	3
Scout Cars	1	1	3
(iv) Towed Equipments			
Trailers, Welding arc and gas ½-ton	1	—	1
(v) "C" Vehicles and Plant			
Tractors, Medium wheeled	1	—	1
Amphibious ferries (Le Bac)	—	2	4
Ramp Units	—	4	8
Deck Units	—	8	16
(vi) Weapons			
LMGs .303	2	14	28
Rocket Launcher 3.5 in.	2	2	6

The Lüneburg Memorial Stone

By Major-General Sir Eustace F. Tickell, KBE, CB, MC

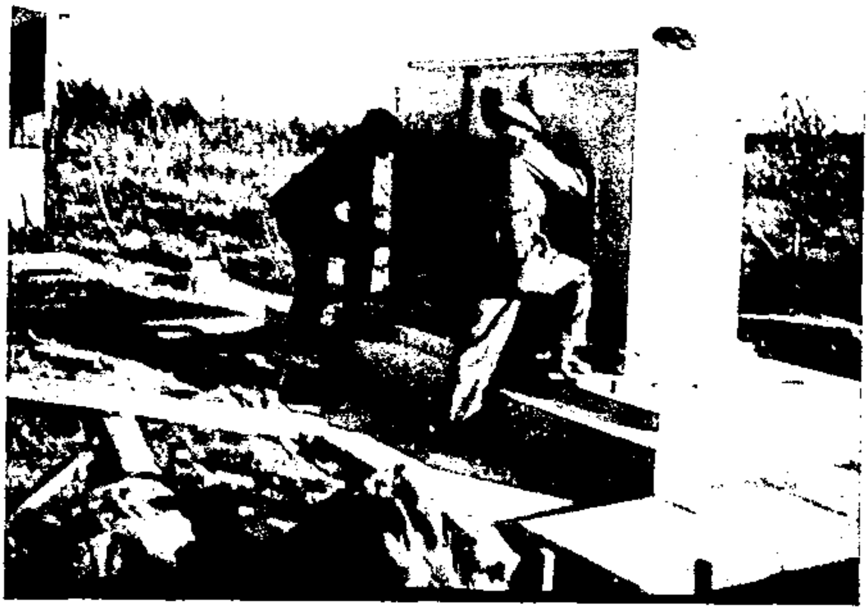
The memorial originally erected on the site of the German surrender in 1945 was installed in its present position in front of the New Buildings, at the Royal Military Academy, Sandhurst, by Field-Marshal Montgomery on 29 November 1958. The Sapper work in connexion with the memorial is perhaps worth recording.

The design chosen was the work of Corporal S. H. Fisk, RE, an architectural draughtsman employed in the office of the Chief Engineer, 21 Army Group. Competitive designs had also been submitted by other members of his staff and of the staff of the Chief Engineer, 2nd Army.

The erection, including the quarrying, masons-work and transportation, was carried out, with some German assistance, by a detachment of the 885 Quarrying Company, RE, under Lieutenant R. D. McLeod. The granite was obtained from the Braunlage quarry in the Harz mountains close to the Russian Sector, but it was found very difficult to produce flawless blocks for the two largest of the main components, as these each weighed about 3½ tons.

The bronze plaque and shield were cast at Hanover, again with some German assistance, by No. 5 Engineer (Base) Workshop, commanded by Lieut.-Colonel W. Reid. The patterns, now in the RE Museum at Chatham, were entirely hand-carved by Corporal Slater, RE. With the facilities available the casting presented many technical difficulties.

Meanwhile, the site on Lüneburg Heath had been prepared and the concrete foundation laid by a German-manned works section under Major Arnall, RE, on the staff of 159 CRE, Works.



Placing the Bronze Plaque on the Memorial on Lüneburg Heath. October, 1945

The work, as originally planned, was completed during October 1945, but the access path and chain surround were added later, the chains being provided by No. 5 Engineer (Base) Workshop.

The memorial was dismantled under Sapper arrangements during the autumn of 1958, and re-erected at Sandhurst by a detachment of 17 Field Squadron.

The inscription reads:

HERE, ON 4th MAY 1945, A DELEGATION
FROM THE GERMAN HIGH COMMAND
SURRENDERED UNCONDITIONALLY
TO FIELD MARSHAL MONTGOMERY
ALL LAND, SEA AND AIR FORCES
IN NORTH-WEST GERMANY, DENMARK
AND HOLLAND

Above the plaque is a shield bearing the badge of 21 Army Group.

Earth Movement Computations for Military Airfield Construction

By Lieut.-Colonel C. E. Warth, RE, AMICE

Introduction

For some years, the problem of trying to reduce the time and effort required to plan earth movement for airfield construction has been exercising military engineers both in the United Kingdom and the USA. On both sides of the Atlantic the possibility of using electronic computors to aid this work has been studied.

In July, 1957, a number of RE officers representing various branches of the War Office, the SME and the Ministry of Supply, had an interesting discussion with the technical experts of an eminent firm which makes electronic computors. As a result, the Author and two members of his staff were left with the considerable problem of presenting airfield data in such a form that the programming of an electronic computor could be carried out. A remark by one of the experts remained in the Author's mind and that was "We sometimes find that when people have calculations to be carried out by a computor, the necessity for arranging them in a way in which they can be presented to the machine so greatly simplifies them that the computor is no longer necessary" and this is precisely what has happened over the matter of these airfield computations.

It was not long before the Author realized that the existing procedure for these computations was primitive. Here was a prehistoric monster still living when its fellows were dead. The monster had reached its highest possible stage of evolution and could evolve no further. It was necessary to go further back in the family tree and to follow a more fruitful branch and line. In the course of the past year this has been done, the delay being due to the fact that it could only be a spare time occupation. Some lines were followed which were unproductive and had to be abandoned, but it now appears that a full and productive line has been established. Before describing it, however, it is necessary to describe and examine the existing procedure.

Existing Procedure

Having selected, by inspection, the centre-line of the runway on the site, chosen and surveyed a suitable grid covering the formation, the following steps are taken:—

1. Draw a profile of the ground on the proposed centre-line, using an exaggerated vertical scale.

2. On the same drawing mark a proposed grade line for the centre-line of the runway formation. This grade line must conform with the airfield criteria for example

(*a*) Longitudinal gradients not to exceed 2 per cent (1 in 50).
(*b*) Rate of change of gradient not to exceed 0.25 per cent per 100 ft.
(*c*) Distance between IPs for vertical curves 1,000 ft. minimum.

3. Having selected a grade line which appears to give the minimum amount of earthwork and roughly balances cut and fill, draw cross-sections at 100-ft. intervals. (Neglecting over-runs, this involves drawing forty-two accurate cross-sections for a 4,100-ft. runway.) Each cross-section shows the ground level and the appropriate formation profile.

4. Estimate by using a planimeter (or if one is not available, by such means as counting squares on graph paper) the area of cut and of fill on each cross-section.

5. Calculate cut and fill volumes for successive 100-ft. lengths of formation. This is normally done by assuming that the cross-sectional area does not alter for a 50-ft. length on either side of the cross-section being considered.

6. Estimate the balance of cut and fill from these calculated volumes, having deducted earth to be moved across, as opposed to along, the formation.

7. If the cut and fill is poorly balanced, adjust the grade line and repeat steps three, four, five and six.

8. This process may have to be repeated several times until a satisfactory grade line, giving a suitable balance, is obtained.

9. From this stage, the volumes for each 100-ft. length of runway are used to produce a Mass Diagram from which earth movement is planned.

Examination of the Procedure

On the question of time, it will be seen that

(*a*) Step two is intricate and liable to be slow:

(*b*) Step three is very slow and laborious:

(*c*) Step four is also slow even using a planimeter, without which it is positively primitive.

It will also be seen that Steps three and four give scope for considerable inaccuracy whilst Step five must be admitted to be a method of obtaining only a rough approximation of volumes. In short, the expenditure of effort is not justified by the accuracy (or lack of it) which is likely to be obtained.

Grade Line Devices

The first and most obvious improvement applicable to this system is to use devices to speed up the drawing of grade lines.

Assuming the use of an "Imperial" size drawing board for runways not exceeding 6,000 ft. in length, suitable scales would be:

Horizontal	1 in. to 200 ft.
Vertical	1 in. to 10 ft.

This gives the maximum permissible gradient of 2 per cent when drawn, to be 1 unit vertical to $2\frac{1}{2}$ units horizontal. A "see-saw" ruler, which cannot be tilted to a slope greater than this, could be used in conjunction with a T-square to enable grade lines to be drawn without the necessity for checking gradients. Such a device is illustrated in Fig. 1.

It will be seen that this device has two marks on the upper edge of the ruler. These are scaled at 1,000 ft. apart and the marks can be used to ensure that no IPs are less than 1,000 ft. apart. Thus this device provides automatically for adherence to two of the criteria.

A second device, in the form of a celluloid curve, shown at Fig. 2, may be used to draw rapidly the vertical transition curves. It needs no explanation but would clearly save working time.

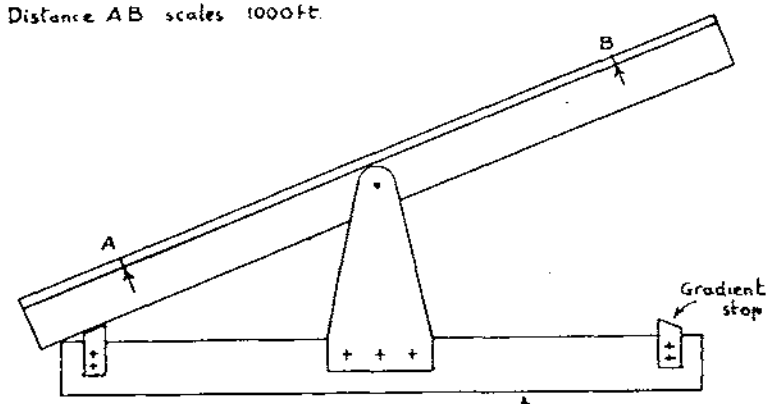


Fig 1 "See-saw" grade line ruler.

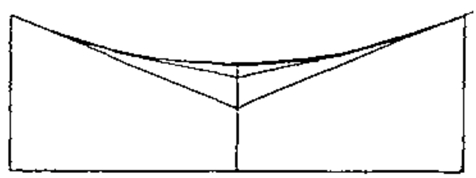


Fig. 2 Protractor for vertical transition curves.

It is hardly necessary to state that from the grade line it is possible to read off the height above OD (Ordnance Datum) of the centre point of the formation at each 100-ft. section to be considered in calculating earth movement volumes.

CROSS-SECTIONAL PROFILE OF FORMATION

Existing criteria for airfields permit of only one possible cross-section for the formation since the maximum permissible cross-falls both to the runway and to the shoulders are also practically the minimum cross-falls required to ensure run-off of surface water. This cross-section, in the case of a certain type of airfield which is to be considered, is shown at Fig. 3. It must be constant throughout one runway but may be handed for any particular runway.

At any one section the height above OD of the centre point is known so that the heights of all other points on the formation can be deduced. It should be noted that this is equally possible if cross-falls are changed, although it is usually stipulated that such changes are undesirable. For simplicity of explanation, this paper assumes a constant cross-sectional profile for the runway and shoulders as illustrated in Fig. 3.

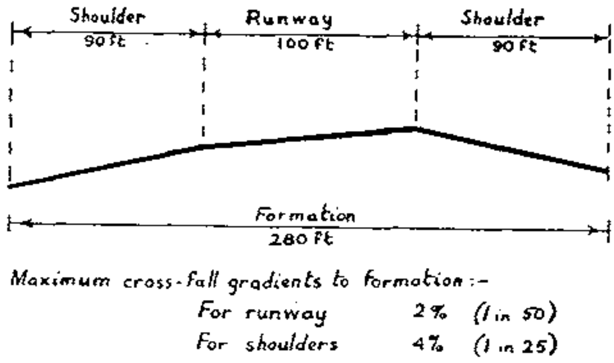


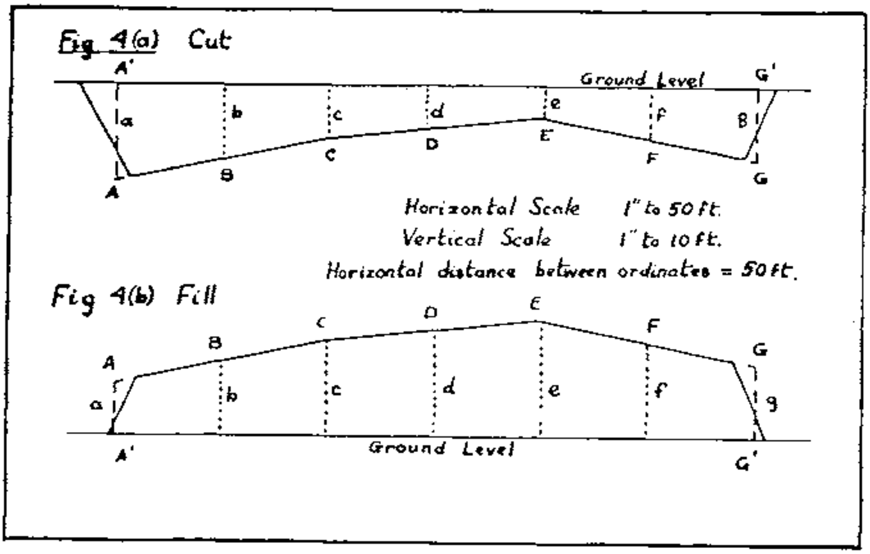
Fig 3. Cross-sectional profile of formation.

The proposition is now put forward that the drawing of cross-sections is unnecessary and that the areas of the cross-sections can be calculated by use of a trapezoidal formula. This eliminates Step three of the existing procedure and greatly simplifies Step four, moreover it is demonstrated that inaccuracies resulting from this new system are likely to be small: they may well be smaller than those resulting from the existing procedure.

Cross-Sectional Areas

One complication is introduced by the assumption in the existing procedure that earth moved from "cut" is compacted to about 9/10ths of its original volume when used for fill. Thus for a given volume "v" of fill (approximately) $1.1v$ of cut must be used. A correction for this can be introduced since it is not proposed in this paper to deviate in principle from the existing procedure.

For simplicity in calculation and because it tends to have a compensating effect in the results, a horizontal intercept of 50 ft. is taken between ordinates for use in a trapezoidal formula. This in effect means that the width of shoulders is taken as 100 ft. instead of 90 ft. Figs 4(*a*) and 4(*b*) illustrate how this provides compensation when the slopes to the sides of cut and of fill are considered. In inspecting these sketches it should be noted that the vertical scale is exaggerated. The actual cross-sectional area is bounded by the continuous lines, whilst the area calculated using the trapezoidal formula is that bounded by the figure A 'ABCDEFGG.'



Where the ordinates at A, B, C, etc., are equal to a, b, c, etc., the net cross-sectional area is given by the formula

$$\text{Area} = \frac{50}{2}\,(a + g + 2\,(b + c + d + e + f))$$

In the case of cut, these ordinates will be negative: in the case of fill they will be positive. Thus a calculation giving a minus quantity will indicate a net area of surplus cut whilst a positive quantity will indicate a net area of additional fill required. In computing volumes of earth, a positive quantity must therefore be multiplied by 1.1 to allow for compaction.

Although this formula appears to be acceptable for cases such as those

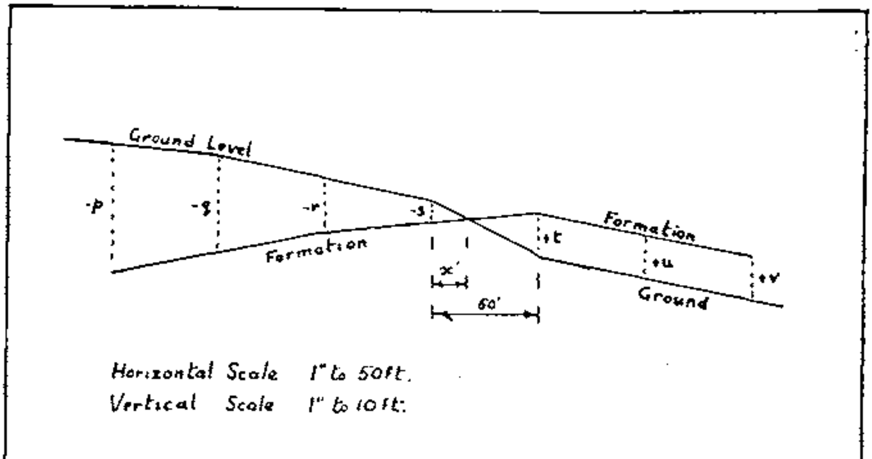


Fig. 5. Cross-section with ground crossfall.

shown in Figs. 4(*a*) and 4(*b*), its ability to be applied where side cut occurs may be doubted. To remove such a doubt, consider a cross-section such as that shown in Fig. 5, where the actual value of the ordinates *a* to *g* are

$$-p, -q, -r, -s, +t, +u, \text{ and } +v \text{ ft.}$$

Then, omitting for the present the problem of compacted fill, the net

$$\text{Area} = \frac{50}{2}(-p+v+2(-q-r-s+t+u)) \text{ sq. ft.} \quad (1)$$

Examining Fig. 5 for cut and for fill separately, it can be seen that

$$\text{Area of Cut} = 50\frac{(p+q)}{2} + 50\frac{(q+r)}{2} + 50\frac{(r+s)}{2} + \frac{s.x}{2}$$

$$= \frac{50}{2}(p+2q+2r+s) + \frac{s.x}{2} \quad (2)$$

$$\text{Area of Fill} = 50\frac{(t+u)}{2} + 50\frac{(u+v)}{2} + \frac{(50-x)}{2}t$$

$$= \frac{50}{2}(t+2u+v) + \frac{(50-x)}{2}t \quad (3)$$

Subtracting (2) from (3) and combining some simple Algebra we find that

$$\text{Net Area} = \frac{50}{2}(-p+v+2(-q-r-s+t+u)) + \frac{50s}{2} - \frac{x}{2}(s+t) \quad (4)$$

(Fill − Cut)

However from similar triangles it can be seen that

$$\frac{s}{x} = \frac{t}{50-x}$$

$$\therefore 50s - sx - xt = 0 \quad \therefore \frac{50s}{2} - \frac{x}{2}(s+t) = 0$$

hence expression (4) is the same as (1) and the latter may be used to calculate the net cross-sectional area even in side cut, provided that the sign convention is used for the ordinates. This is largely borne out by figures in Table I.

An inspection of (1) shows certain negative values which if worked out separately might be expected to give the area of cut, whilst the positive values might give fill. If this is so then

$$\text{Area of cut} = (-)\frac{50}{2}(p+2q+2r+2s) \quad (5)$$

It will be seen that (5) only differs from the actual cut in (2) by the amount

$$\frac{50}{2} \times 2s - \left(\frac{50}{2}s + \frac{sx}{2}\right)$$

which is equal to $\frac{s}{2}(50-x)$ (6)

Bearing in mind that

(i) s is bound to be a very small ordinate therefore (6) can give only a small value as an error,

(ii) When $x = 0$, $s = 0$ therefore the value of (6) is 0,

(iii) When $x = 50$, the value of (6) is 0,

it is clear that in using (5) to calculate cut, only a small error can result. In fact it can be shown that the maximum possible error in sq. ft. = 3.125K, where K is the gradient of the ground cross-fall expressed as a percentage. Thus for a cross-fall of 5 per cent (1 in 20) the maximum error will be 15.6 sq. ft., a very small error quite likely to be exceeded by that produced by ground irregularities between grid points 50 ft. apart.

Thus it may be assumed that the original formula may be used, at any one cross-section, to calculate the area of cut by extracting the negative quantities, and as a corollary to calculate the area of fill by extracting positive quantities, before doing any summation within the formula. This assumption is largely borne out by the figures in Table II in which all cross-falls are 4 per cent (1 in 25) and the cases investigated are:—

Case I	Fall from Left to Right through C
Case II	Fall from Left to Right through D
Case III	Fall from Right to Left through D
Case IV	Fall from Right to Left through E
Case V	Fall from Right to Left through F

TABLE II

CASE	BALANCE (Longitudinal haul)				CALCULATED			ACTUAL		
	CALCULATED		ACTUAL							
	CUT	FILL	CUT	FILL	CUT	FILL	CROSS HAUL	CUT	FILL	CROSS HAUL
I	-	550	-	554	400	990	400	412	876	412
II	400	-	435	-	775	413	413	824	389	389
III	400	-	419	-	525	138	138	547	128	128
IV	100	-	100	-	400	330	330	412	312	312
V	-	1210		1204	100	1320	100	90	1294	90

Note 1. All numbers represent sq ft. of cross-sectional area.
Note 2. Calculated balance is net area from full formula (+10% to fill).

It should here be noted that the small error due to the value (6), is, in all cases, nil. The errors, as in Table I are in fact due to the assumptions made at the extremities of the cross-section, in evolving the formula.

Summary of Basis for New System

To simplify explanation, no differentiation is being made between ground levels before and after stripping top soil, nor between formation level and paved surface level. Simple and accurate adjustments can, of course, be made for these.

The new system proposed, apart from simplifying the plotting of a grade line, merely eliminates the drawing and the measuring of areas of a large number of cross-sections by substituting very simple calculations.

The basis of this new system is dependent on obtaining, for each cross-section, seven ordinates each with the correct value and sign (+ or −) and then separating negative values for cut and positive values for fill from the trapezoidal formula using these ordinates.

Since the ordinates within the brackets, after multiplication by 1 or by 2 as appropriate, are (after summation) all multiplied by $\frac{50}{2}$ to obtain cross-sectional areas in sq. ft., and subsequently again multiplied by 100 (or 50 in the case of the two end cross-sections) to obtain volumes of earth cut or fill in cubic feet, there is a common factor throughout all calculations. This factor is $\frac{50}{2} \times 100 \times \frac{1}{27}$ to obtain volumes in cu. yds. If this factor is omitted from calculations, the calculations themselves will give volumes in units each of which is 92.59 cu. yds. Let such a unit be known as an "acu" (airfield cubic unit). All balancing of cut and fill and the plotting of mass diagrams can be carried out in these units. It is only necessary to convert to cu. yds. in the final stage when actual application of plant is being considered.

The following numerical example may make this clear:—

Cross-sectional area $= \frac{50}{2}\left(-8 + 4 + 2\left(-4 - 2 + 1 + 2 + 3\right)\right)$ sq. ft.

$\therefore$ Area in cut $= (-)\,\frac{50}{2}(8 + 8 + 4) = -\frac{50}{2}(20)$ sq. ft.

$\therefore$ Area in fill $= +\frac{50}{2}(4 + 2 + 4 + 6) = +\frac{50}{2}(16)$ sq. ft.

Therefore

Volume in cut $= (-)\,\frac{100}{27} \times \frac{50}{2} \times (20)$ cu. yds. $= -$ 20 acu

Net volume in fill $= +\frac{100}{27} \times \frac{50}{2} \times (16)$ cu. yds. $= +$ 16 acu

$\therefore$ Volume of fill adjusted for compaction $= 1.1 \times 16 = +\ 17.6$ acu

Hence volume balance for Longitudinal haul $= -20 + 17.6$ acu

$= -2.4$ acu

Whilst volume for cross haul = 17.6 acu from cut to fill.

Procedure for New System

The preparatory work up to the end of Step two is the same as for the existing procedure except that the two devices should be used to speed up the plotting of a grade line. Thereafter

Step three. Using the proforma shown in Fig. 6, fill in the identification data at the top followed by line Z which is based on transverse criteria for the airfield. Then for each cross-section three lines have to be filled in, in the following order:—

(*a*) Line (i) Column D. This Reduced Level comes from the grade line at the chainage of the section being calculated.

(*b*) Line (ii) Columns A to G. As these are grid intersection points, the reduced ground levels will be accurately known from the survey.

(*c*) Complete Line (i) using the corrections shown in Line Z.

(*d*) In each column subtract the number in Line (ii) from that in Line (i) and record this value WITH ITS SIGN in Line (iii) which then provides the value of the ordinates.

Step four. Using the proforma shown in Fig. 7, complete the columns for each cross-section as under:—

(*a*) Lines one to seven, use the figures recorded at (*d*) in Step three. Except for the first and last, the ordinates are multiplied by two.

TABLE I

	Description	Net Cross-sectional Area (sq ft) Calculated	Actual ½ Slopes	Actual 1/1 Slopes	% Error
	Ground horizontal				
1	At level of E	-700	-694	-672	+0·9
2	5 ft above E	-2200	-2286	-2193	-3·7
3	5·6 ft below E	+980	+968	+966	+1·3
4	3·6 ft below E	+383	+390	+388	-1·5
	Ground crossfall 1/30 right to left				
5	Cutting D	-400	-413	-387	-3·2
6	Cutting C	-600	-623	-589	-3·7
7	Cutting E	-200	-217	-194	-7·8
	Ground crossfall 1/30 left to right				
8	Cutting D	-400	-398	-356	-0·5
9	Cutting C	+400	+365	+377	+9·6
10	Cutting E	-1200	-1138	-1066	+5·4
	Ground crossfall 1/20 right to left				
11	Cutting D	-400	-458	-415	-12·8
12	Cutting E	+50	0	-28	+∞

Note In the % Error column the actual area is based on ½ slopes to sides of cut or fill

LEVEL AND ORDINATE SHEET

Location ....

Serial No. ....

SEC No.	POINT / DETAIL	A	B	C	D	E	F	G
	Z. Rel fmn level	-5·0	-3·0	-1·0	0	+1·0	-1·0	-3·0
1.	(i) RL's on fmn	281·0	283·0	285·0	286·0	287·0	285·0	283·0
	(ii) GL	289·0	287·5	286·0	284·0	283·5	282·5	282·0
	(iii) Ordinates	-8·0	-4·5	-1·0	+2·0	+3·5	+2·5	+1·0
2	(i) RL's on fmn	283·0	285·0	287·0	288·0	289·0	287·0	285·0
	(ii) GL	290·0	289·5	289·0	289·0	288·0	286·5	286·0
	(iii) Ordinates	-7·0	-4·5	-2·0	-1·0	+1·0	+0·5	-1·0
3	(i) RL's on fmn				289·8			
	(ii) GL	291·5	291·5	291·0	290·0	289·5	289·0	289·0
	(iii) Ordinates							
4	(i) RL's on fmn							
	(ii) GL							
	(iii) Ordinates							
	(i) RL's on fmn							
	(ii) GL							
	(iii) Ordinates							
	(i) RL's on fmn							
	(ii) GL							
	(iii) Ordinates							

Fig. 6

Negative values go into the "Cut" column and positive into the "Fill" column.

(*b*) Each column is added and totals recorded in line eight.

(*c*) It is then necessary to adjust the "Fill" column for compaction by adding 1/10 (at line nine) to the total.

(*d*) Line ten, being the sum in each column of the numbers in lines nine and ten, then gives the volume of cut and fill in acu's.

(*e*) Line eleven, normally has the same numbers in line ten EXCEPT in the case of the end cross-section at either end of the formation when the numbers are half those in line ten.

(*f*) Line twelve has only one number for each cross-section and this is the algebraic sum of cut and fill, in acu's. A negative quantity denotes excess of earth from cut and a positive one excess requirement of fill.

(*g*) Line thirteen has only one number, which is the smaller of the two in line eleven giving the cross-haul in acu's.

(NOTE, Figs. 6 and 7 have been filled in to give an example of the procedure for the first two sections of an airfield.)

Step five, is to balance cut and fill over the length of the formation. If the balance is unsatisfactory a new grade line is plotted.

Step six. When it comes to correction of volumes the new system really comes into its own (if it has not already done so).

Inspection of the proforma at Fig. 6 will show that for one particular cross-section, if the grade line has at that point been raised by "y" ft., all figures in Line (i) will be greater by "y". Therefore all figures in Line (iii) will be altered by a value "$+y$".

Turning to Fig. 7, the result of this change in grade line is therefore to adjust the figures in lines one and seven by "y" and those in lines two to six by "$2y$". The change in volumes can be made merely by inspection. If, however, one is only investigating the longitudinal haul, a direct correction of "$12y$" can be applied to the figure in line twelve.

Thus if the grade line is lowered 6 in., $y = -\frac{1}{2}$ ft.

The correction $= -6$ acu's, which in the case of Cross-Section 1 would change the total from 0·1 acu's surplus cut to 6·1 acu's of surplus cut. (The additional adjustment for compaction of fill has here been omitted as it is negligible unless the grade line has been altered to an abnormal extent.)

CORRECTIONS FOR INACCURACIES

The formula used for this new system although almost certainly accurate enough for practical purposes, has inaccuracies which are due to the assumptions made for the outer edges of the formation. As might be expected these inaccuracies are exaggerated when the ground has a cross-fall. The greater the gradient of the cross-fall, the more will these inaccuracies be increased. Now it is perfectly easy to provide corrections based on the value of end ordinates and the proforma shown in Fig. 7 could have additional lines for the application of these corrections. The essential aim in evolving this system has, however, been to maintain simplicity without involving unreasonable inaccuracy and it is felt that this has been achieved. For this reason the application of additional corrections is not recommended.

It is of course possible to have a very much cruder system than that now proposed, one for instance, based purely on the grade line. In some circumstances this would be adequate particularly where there were no appreciable

VOLUME CALCULATION PROFORMA

Location **Serial No.**

Line	Detail	Cross-section No 1		Cross-section No 2		Cross-section No		Cross-section No	
		Cut (–)	Fill (+)	Cut (–)	Fill (+)	Cut (–)	Fill (+)	Cut (–)	Fill (+)
1	1 x ordinate "a"	8·0	–	7·0	–				
2	2 x ,, "b"	9·0	–	9·0	–				
3	2 x ,, "c"	2·0	–	4·0	–				
4	2 x ,, "d"	–	4·0	2·0	–				
5	2 x ,, "e"	–	7·0	–	2·0				
6	2 x ,, "f"	–	5·0	–	1·0				
7	1 x ,, "g"	–	1·0	1·0	–				
8	Total	19·0	17·0	23·0	3·0				
9	Add 10% Fill		1·7		0·3				
10	Adjusted Total	19·0	18·7	23·0	3·3				
11	Corrected Total	9·5	9·4	23·0	3·3				
12	Longitudinal	0·1	–	19·7	–				
13	Transverse		9·4	–	3·3				

Fig. 7.

NOTES ON FIG. 7

1. Lines eight to thirteen inclusive give volumes in "acus" (i.e. units of 92.59 cu. yds.). For a length of formation for 50 ft. before and 50 ft. after a cross-section. In the case of an end cross-section this becomes a volume for a 50-ft. length only (before or after the cross-section).

2. Corrections for the outer edges of the formation where inaccuracies occur can be applied in two ways:—

(*a*) On the assumption that the side slopes to cuts or fills are at a gradient of 1 in 2, a correction based on the end or outer ordinate can be applied.

This does not allow for additional cut on "cleared" areas.

(*b*) In the case of cut a cleared area 60-ft. wide at a maximum rising gradient of 1 in 10 should be provided. For this, additional ordinates could be obtained at a distance of 200 ft. from the centre line of the runway. These could be denoted by "*l*" on the left and "*r*" on the right.

3. In the case of 2(*a*) the corrections to be applied to line eight of where the end ordinate is "*y*" ft. are:—

(i) If "*y*" is positive

Add $\frac{2}{50}(y^2-9.2y-4)$ to the value of the FILL.

(ii) If "*y*" is negative

Add $\frac{2}{50}(5.8y-y^2)$ to the value of CUT.

In the latter case the correction is not worthwhile making unless "*y*" exceeds (—) 7 ft.

It may be observed that the figures in brackets are the actual areas in sq. ft. and the Factor $\frac{2}{50}$ is to convert them to the same units as are in line eight.

4. In the case of 2(*b*) and an end ordinate of "*y*" ft.:—

(i) If *y* is positive, apply the same correction as in 3 (i).

(ii) If *y* is negative

Add $y+r+0.04r^2-1.03$ to the value of CUT in line eight.

(Substitute "*l*" for "*r*" where appropriate).

6. The Table can be altered to permit corrections to be carried out as a drill. This would best be done by having the corrections calculated in lines above line one as at present shown.

cross-falls nor deep cuts or fills. However, the aim of all these computations is to plan the economical use of plant and excessive inaccuracy in the computations renders them valueless. It is felt that the system now proposed provides adequate accuracy for all likely circumstances.

ACKNOWLEDGEMENTS

The Author wishes to express his thanks to Major J. P. Fitzgerald-Smith, RE, for abetting him in this heresy in its earliest stages of development; to Major J. R. de G. Pilkington, MC, RE, for listening to this gospel and also making the suggestion which led to the evolution of acu's, and to Captain Karl Snider, RCE, for giving some refresher tuition on the existing procedure.

Loading and Unloading

By Captain P. R. Knowles, RE

The reader hoping to find assistance in this article for planning his weapon training programme will, despite the title, be disappointed. The title is intended to be a simple way of describing one RE activity—the discharging and loading of cargo into ships.

Most professions and trades possess a technical jargon which is used to impress and confuse the outsider. This is certainly true in the shipping world which has had time to develop an extensive vocabulary during the centuries since the ship was first invented. It is this "mumbo jumbo" which often so impresses the outsider that he despairs of understanding such a complex subject and leaves his affairs in the hands of the expert. The aim of this article is to show that a little knowledge may not be quite so dangerous a thing as the expert would like one to think.

The 1939–45 war proved that in large scale operations port operating troops are in great demand. By 1945 the Transportation service had increased to something like twenty times its size in 1939. Modern war demands vast tonnages of every kind of store and a great effort has to be put into moving these stores. When mobilization for limited or global war is complete then there will be sufficient troops to cope with the port operating demands of such a war, but at the beginning normal sapper field squadrons may have to be used.

The same problems have to be faced in the unusual peace time in which we live. Since 1945 the Transportation service has shrunk to little more than a cadre. Most of the Army's port operating in peace time is done at established ports using civilian labour and equipment. The small Transportation service provides a nucleus of trained officers and men to help the inevitable expansion should there be a war.

But in these unsettled times there may be demands for troops trained in loading and unloading that cannot be met from the limited specialist resources. Possibly a landing has to be made in a part of the world where there are no civil port facilities. Specialist port operating troops are not available; the familiar cry of "Send for the sappers" is heard. Can we answer it confidently? Is it possible to use an ordinary field squadron given a short period of training for port operating?

The result of training carried out by a field squadron recently shows that in a short time a perfectly adequate organization can be built up. Provided officers and men realize that behind the technical jargon of loading and unloading there are the old familiar principles of field engineering then there should be no difficulty in making the changeover.

Organization

The organization of a troop of a port operating squadron is shown below. This organization is designed to work an average cargo ship with five hatches.

Subaltern	1	Checkers (Clerks MC)	8
WOII	1	Carpenters	1
Sergeants	4	Clerks (MC)	1
Stevedores	56	Carpenter's mate	1
Crane operators	5	General duties	1
Heavy crane operators	1	Driver	1

The backbone of the troop is its fifty-six stevedores. They are the men who do the loading and unloading. Checkers are responsible for noting the amount of cargo loaded or unloaded and such a job can be done by any man capable of counting and writing. The carpenter and his mate are required to repair broken boxes, to assist in chocking cargo in the hold, to secure deck cargo and to strengthen holds. Such work is within the capabilities of a field squadron carpenter.

For a five-hold vessel the troop will be broken down into five gangs, one per hold thus:

Stevedores	11
Crane operator	1
Checker	1
	13

Now how does a field unit measure up to this organization? On the latest establishment a section of a field troop has fourteen men and would seem an excellent unit to turn into a gang. One field squadron could then form nine gangs or, if squadron headquarters were included, ten gangs. These would be enough to work two shifts a day on a five-hold ship. The bulk of the gang is stevedores and for the type of operation envisaged loading and unloading would be done using the ship's gear making crane operators unnecessary.

Working a Ship

The first problem, that of converting the organization of a field squadron is easily achieved. Now how about the actual working of the ship and the skills involved. Do they take so many years to master and are they so difficult? Given a little training, by using the field engineering principles known to every sapper it is possible to work a ship effectively using "amateur" labour. One must not however imagine that the speed of work, the slickness in handling cargo and the stowing will be comparable with that done using trained stevedores; the perfection of their art takes many years, but the field sapper will produce results with a minimum of training which are quite surprising.

The techniques of loading and unloading are gone into in some detail here so that the type of work and its problems can be better understood by the reader. The first task is to master the technical jargon. For that the sapper has already got a basic knowledge from his watermanship and field engineering training. Parts of the ship and names of the various rigging ropes and tackles used in the derricks are known to him. Some of the more unusual words are explained in Appendix A.

Having learned his vocabulary the sapper can carry on most technical conversations with the ship's officers. This is a very important point for the captain of the ship has a very large say in the stowing of his vessel. In fact the stowing must be to the captain's satisfaction before he will sail.

There are two main methods by which cargo can be handled—using dockside cranes or ship's gear. The former will not be discussed here, only the use of ship's gear is considered because it is probable that the cargo will have to be discharged into lighters moored alongside. This will certainly be the case in undeveloped countries and will probably apply in nuclear war where the use of existing ports may be prevented by the need for dispersion to avoid presenting a nuclear target.

Ship's Gear

The rigging of the ship's derricks is usually done by the crew of the ship. However, there may be occasions when the unloading unit will be required to help or even to rig the derricks unaided. A knowledge of the various rigs is useful but assistance can always be sought from the chief officer. For that reason only the most common rig, the Union Purchase is described here. Figure 1 shows the rig (Page 148).

The operation of the Union Purchase is a cunningly simple idea. The midship derrick plumbs the hold, the yardarm derrick plumbs the barge or quay. The runners from each are joined together at the cargo hook. If for example cargo is being lifted out of the hold the strain is taken first by the midship derrick, the other runner being left slack. When the load has been raised clear of the deck the yardarm runner is tightened and the load is thus pulled across towards the side of the ship. The midship runner is now slackened and the load lowered using the yardarm runner.

The safe working load of the normal ship's derrick is usually about five tons so that if heavier loads are to be moved a large derrick is required. Most ships are fitted with such a derrick, known as a Jumbo. This may be able to lift loads up to 100 tons. Generally only one Jumbo is fitted, working into the main hold. Certain ships which are specially designed to carry heavy cargoes have a number of Jumbos some of which may be able to lift weights in excess of 100 tons. The Jumbo requires four winches to operate it, one to raise and lower the load, one to raise and lower the derrick and two to swing the derrick from side to side.

Stevedores

The trade of stevedore does not solely include a knowledge of stowing cargo. A stevedore must be able to operate ship's winches and also be able to take charge of the loading or unloading of a hold. This job, known as hatchwayman, is a most important one. The hatchwayman has control of his gang as it works in the hold, operates the winches, and works in the lighters or on shore. He controls the raising and lowering of cargo by the derricks. It is important that he be given complete charge of the gang. Safety demands that only the hatchwayman be allowed to give signals. There is nothing unusual in this, it is normal practice whenever lifting is done in field engineering.

The safety aspect of loading and unloading needs particular emphasis. Perhaps the most obvious fault of untrained men is their neglect, through ignorance, of safety precautions. In the early stages it is better to accept a slower rate of working than risk accidents. Holds of ships are often very deep and a small item dropped into a hold from the deck can be moving very fast when it reaches men working below. Safety precautions are only commonsense but unless they are stressed from the very beginning men will neglect them with fatal results. Some of the important points are noted below:

Discipline is the prime requirement. The hatchwayman must demand and get instant obedience to his orders.

The gear used must be serviceable. It should be inspected before use and during use to make sure it is not being worn or chafed.

Men must never throw anything into the hold, even if the hold appears clear of men. It takes a little time for an object thrown from the deck to reach the bottom of the hold—time enough for someone to move into the line of fire.

Men must keep clear of loads being lowered or raised.

Smoking must never be permitted in holds.

Hatches and Holds

Ships' holds are, except in the smallest vessels, multiple storey affairs, that is they contain a number of decks below the main deck. These decks are known as 'tween decks and they each have a hatch through which the next 'tween deck can be reached. The construction of the normal hold and its main hatch are shown at Figure 2 (Page 148). A knowledge of the method of removing and replacing hatches is important for it may well have to be done by stevedores. The wooden hatch boards which cover the hold are supported on metal beams. The boards are covered with tarpaulins which are battened down at their sides by a system of metal bars held in place by wooden or metal wedges. The beams are lifted out using the derricks and they and the boards should be carefully placed where they cannot interfere with the working of the hold. The beams are not normally interchangeable and are marked to show their position in the hatch. They are fitted with bolts which prevent the beams moving upwards and it is most important that if not all the beams are removed from the hatch that the bolts on the remaining beams are home. Otherwise, if a load catches on one of the beams it may dislodge the beam into the hold. The very least that can happen then is that the beam will be bent.

The capacity of a ship's hold is normally shown in tons measurement. The ton measurement is a measure of cubic capacity and not of weight and is based on the relationship that 1 ton measurement is equal to 40 cu. ft. Another consideration in loading a ship is the amount of cargo which can be loaded without exceeding the limit set by the Plimsoll line. This is measured by weight in tons deadweight. Thus cargo being loaded must be assessed in two ways; by weight and volume. In making a stowage plan it is important to know the volume of the cargo in tons measurement. If this is not known then reference can be made to a table showing the "densities" of various types of cargo. Some typical values are:

Commodity	*Cu. ft. per ton deadweight*	*Tonnage (measurement)*
1	2	3
Ammunition 303 in. cases	25	0 tons 25 ft.
Brooms and handles loose	285	7 tons 5 ft.
Herrings tinned cases	50	1 ton 10 ft.
Saddles loose	240	6 tons 0 ft.
Torpedoes	169	4 tons 9 ft.

The measurement tonnage in column 3 is obtained by dividing the cubic capacity in column 2 by 40. Any remainder is shown as "ft." These examples show how shipping charges are worked out for loads by using either the deadweight or measurement tonnage whichever is the greater, e.g. Ammunition would be charged for by deadweight tonnage whereas all the others would be charged for by measurement tonnage.

Cargo Handling Gear

Suitable gear for handling various types of cargo has been developed and the correct gear should be used if available. Cargo handling gear can be made of cordage, steel wire rope or chain. Some of the more common types of gear are described here and illustrated at Figure 3.

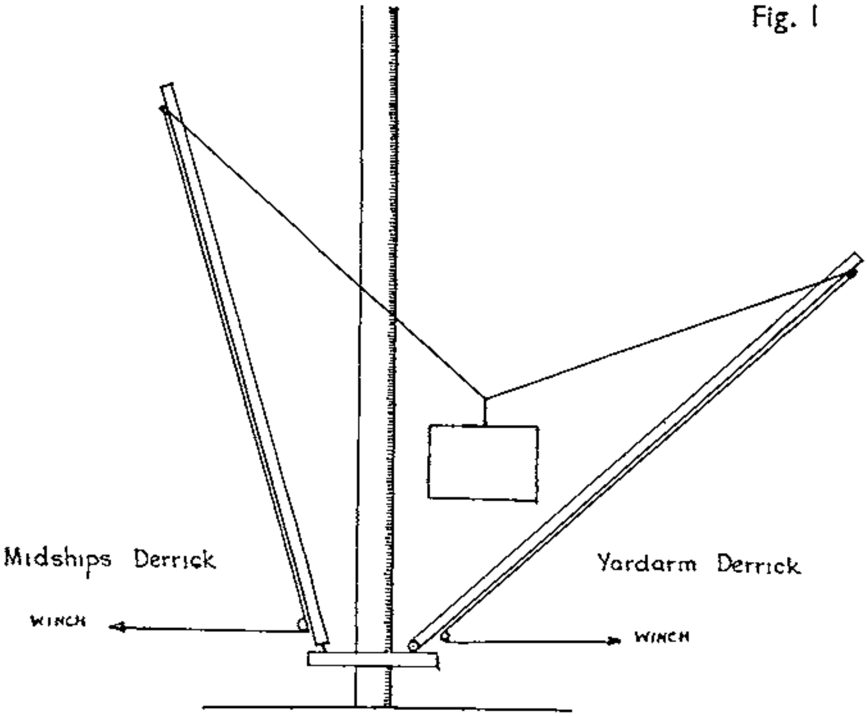
Name	*Material*	*Use*
Sling } Snotter }	Rope or wire	For lifting boxes, sacks, etc., which can stand crushing.
Set of fours (Quadruple chain sling)	Chain	For lifting ammunition trays or rigid loads into which the hooks can be fitted, e.g. Bailey Bridge parts.
Cargo net	Rope	Useful for a variety of stores particularly when fitted with a circular net board.
Sling	Chain	For rails and pipes.
MT Sling	Wire and chain	A special sling for lifting MT. Similar but much stronger slings are used for lifting tanks and locomotives.

Roller conveyer. Where many small packages have to be moved into or out of holds lengths of roller runway can be very useful in speeding up the work. They are also used to help the placing of cargo into the wings of the hold.

Stowage

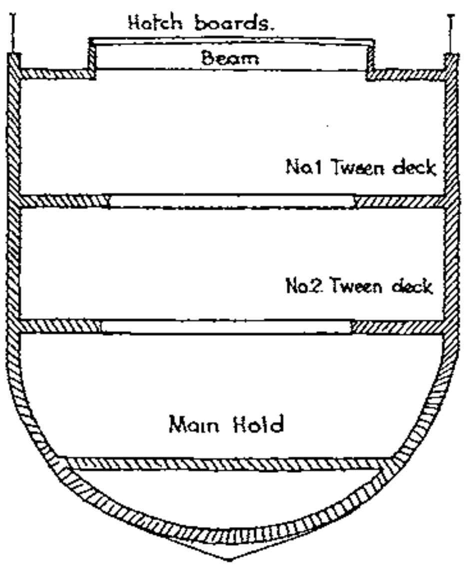
The preparation of stowage plans is normally done by specialist staff, in consultation with the ship's master. However, it is useful to know what

Fig. 1



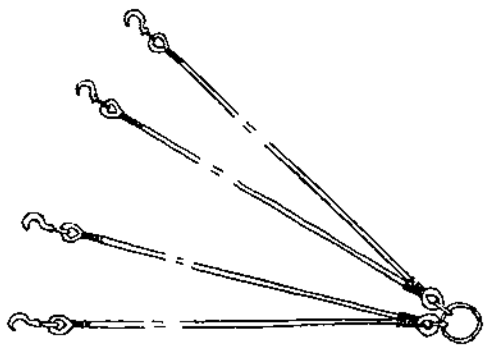
UNION PURCHASE.

Fig. 2

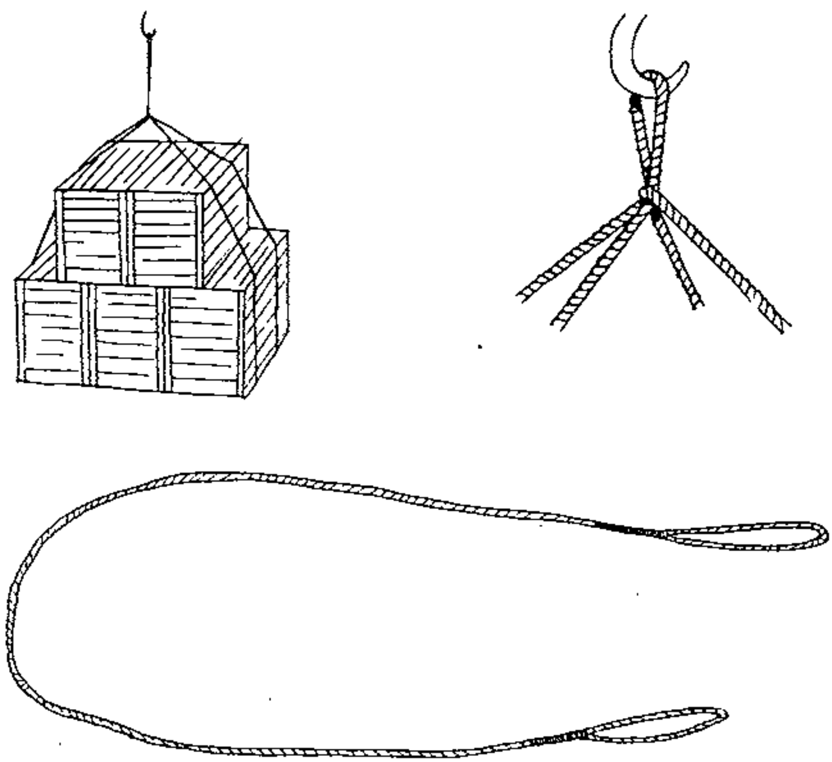


SECTION THROUGH TYPICAL HOLD

Fig. 3

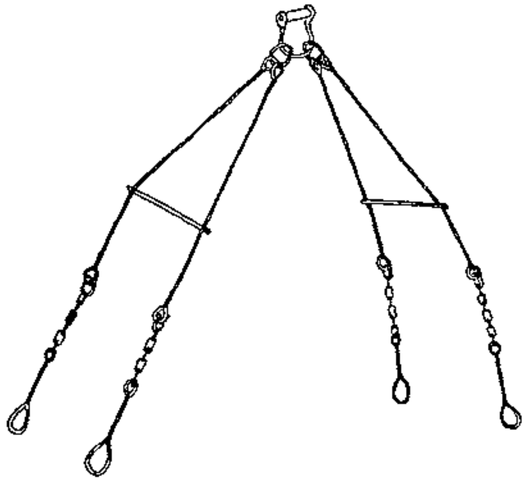


QUADRUPLE SWR SLING

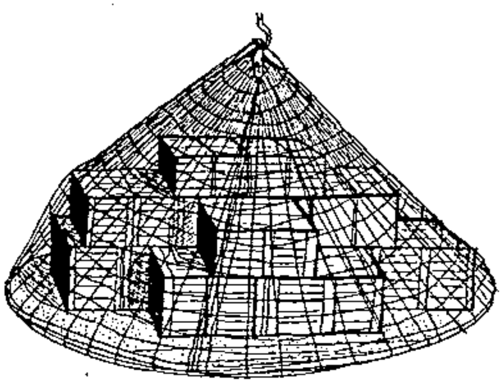


ROPE SLING &
SWR SNOTTER

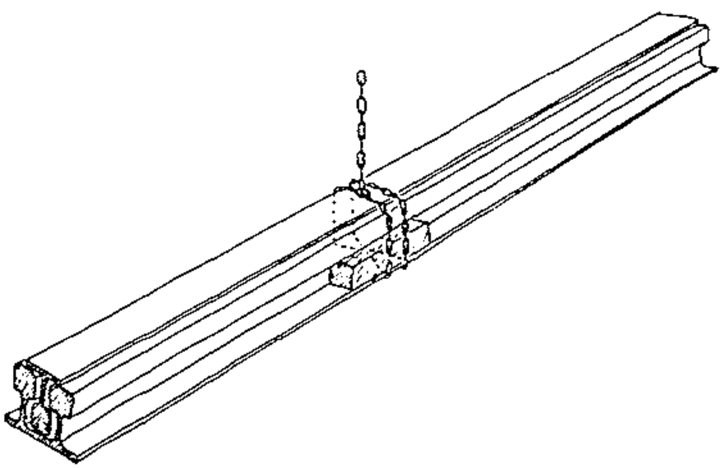
Fig. 3



MT LIFTING GEAR WITH HUB STROPS



ROPE CARGO NET AND BOARD



CHAIN SLING

principles govern the stowing of cargo. The most important factor is the stability of the ship. Ships are classed as stiff or tender depending on their rolling characteristics. A stiff ship is bottom heavy and tends to roll only a short way with a short period of oscillation. A tender ship is top heavy and has a long roll with a long period. Either condition is bad; the former because it is unpleasant, the latter because it is dangerous. Cargo must therefore be stowed so that as far as possible it tends to right the stiff or tender condition. The tender condition is particularly bad because incorrect stowage will aggravate it and in the extreme case will cause the ship to turn turtle.

Two other considerations are important. The stowage must be such that cargo can easily be unloaded at each intermediate port and the trim of the ship must be correct. Normally the ship will be trimmed to be slightly down by the stern and intermediate discharge of cargo should not affect this.

Practical Training

To show what can be done using a field squadron here is a description of an exercise carried out recently. The task was to unload a ship moored in a seaway into lighters; to unload from these lighters into railway wagons on a quay, and finally to unload the wagons into a storage shed. The stowage of the two-hold ship is shown in the stowage diagram at Figure 4. The weight of stores to be moved was approximately 300 tons.

The squadron was organized into seven gangs and the total working strength was brought up to nine gangs by bringing in two gangs of partially trained stevedores. The gangs were distributed as follows:

On board	3 gangs
On the quay	3 gangs
In the shed	3 gangs

No assistance was given by experts, the planning of the operation was done entirely by the squadron officers. The planning included ordering of the cargo handling gear required, deciding the type of rig needed for ship and shore derricks and allocating labour so that unloading in both the ship's holds went at the same rate.

The ship was taken over with hatches covered and derricks stowed. Derricks were rigged and hatches uncovered and unloading commenced on Tuesday morning. By the following Friday morning No. 1 hold had been entirely cleared and in No. 2 hold all that remained were three heavy cases of MT stores. At 1400 hrs. on Friday all stores had been stowed in the cargo shed. As can be seen from the stowage plan the stores were varied and called for a variety of cargo handling gear. Changes in the rig of the derricks were necessary to deal with the heavier items which included two large Braithwaite tanks stowed as deck cargo and a 3-ton truck.

All this work was done by men who had had only three weeks instruction in loading and unloading. The only professional assistance required was in the moving of barges from ship to shore by tug, the operation of a 6-ton portal crane on the quay and shunting of railway wagons. Even this was not strictly necessary as there were in the squadron men capable of operating tugs and cranes.

Had fully trained stevedores been employed the unloading might have been finished more quickly. But the speed at which the amateurs worked

FIG 4

STOWAGE PLAN

RE STEVEDORE

NORMAL FULL SPEED 16 KNOTS

DAILY CONSUMPTION 40 TONS COAL

DEADWEIGHT SUMMER 560 TONS OF 20 CU FT.

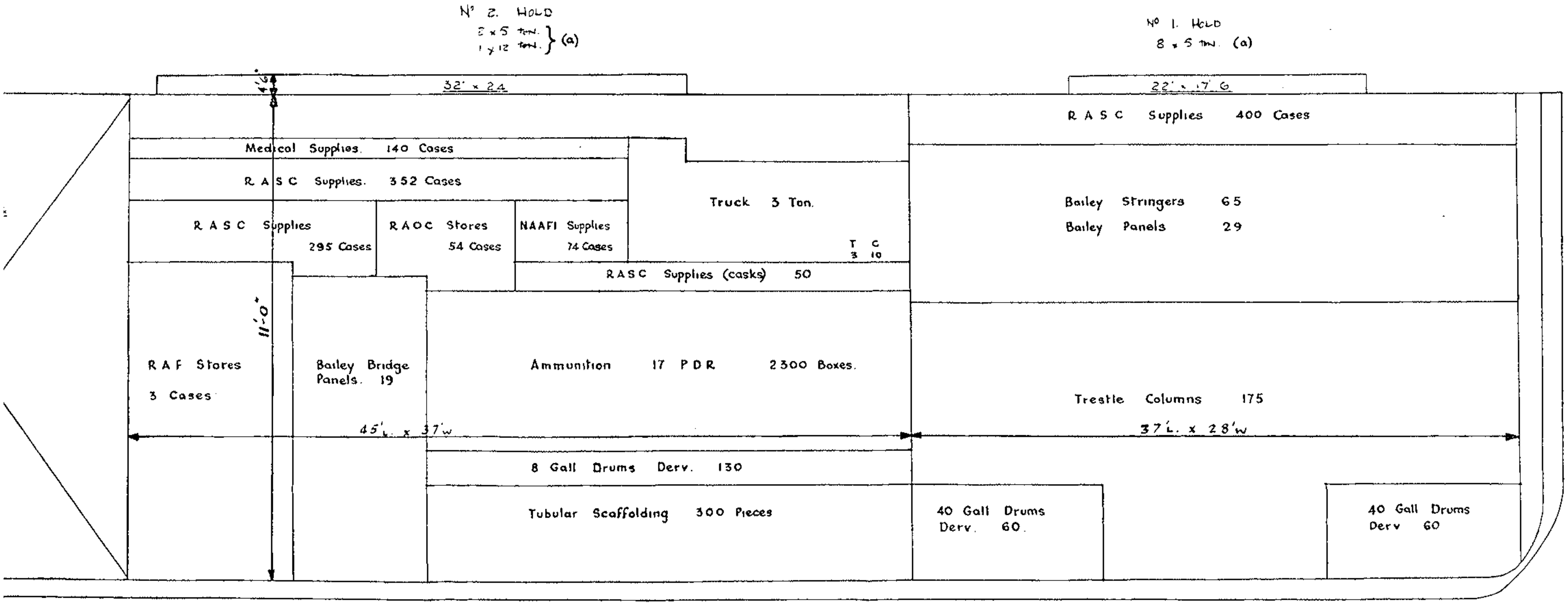
WINTER ______

AL CAPACITY
TOTAL CAPACITY
(EXCLUDING BUNKERS) 800 TONS OF 40 CU FT

(a) LIFTING CAPACITY OF DERRICKS

LIFTS OUTSIDE DERRICK CAPACITY

Nº	TYPE	WEIGHT	WHERE STOWED



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surprised the experts. It should be particularly noted that there were no accidents to men although some damage was done to the ship's rail when it was lifted in error by a derrick.

CONCLUSION

In the field of military engineering we must always be prepared to take on unusual tasks at short notice. We must try to keep our minds flexible and not over-specialize so that we can adapt ourselves to a variety of jobs. Practical schemes have shown that the loading and unloading of ships can be carried out by field squadrons after a short period of training. This is just one illustration of that flexibility which is so necessary if we are to retain our reputation as military engineers.

APPENDIX A

SOME USEFUL TERMS

Bale capacity	The volume available in a ship or hold measured in cubic feet.
Batten	A length of wood or steel used to secure tarpaulins over hatches.
Bill of lading	A receipt for goods loaded on a ship.
Booby hatch	Small hatchway allowing men to enter hold without uncovering main hatch.
Breaking out	The breaking bulk of cargo for discharge.
Bullrope	Wire rope used for dragging cargo in the hold. Also another name for the topping lift used for hoisting a derrick.
Bung up and bilge free	Method of stowing casks so that the bungs are uppermost and the lower portion not resting on the deck.
Bunker	Ship's fuel compartment.
Ceiling	Wooden floor fitted to the bottom of a hold.
Crutch	Support which holds a derrick when lowered.
Derrick table	A shelf built round a mast to support the heels of derricks.
Drift	Clearance between cargo hook and anything over which it has to pass.
Flooring out	Spreading dunnage or cargo over the ceiling of a hold.
Full and down	When a ship is full of cargo and down to her maximum legal draught marks.
Goalposts	A pair of sampson posts connected at the top.
In stream	When a ship is anchored in a waterway not at a wharf or jetty.
Lighter	Craft used to carry cargo between ship and shore. A lighter becomes a barge when it is moved from a port area on a line of communication.
Midship derrick	The derrick plumbing the hatch.
Outboard derrick	Derrick rigged to plumb over the ship's side.
Peak tanks	Tanks situated one in the bow and one in the stern for storage of fresh or ballast water.
Plumb	Directly below cargo hook is the point plumbed by the hook.
Pontoon hatch cover	Steel hatch cover unsupported by beams.
Sampson posts	Upright posts erected on a vessel's deck to support derricks.
Save-all	A net rigged between ship and quay to prevent cargo falling into the water.
Strike	To take cargo from trucks, etc.
Yard-arm derrick	See outboard derrick.

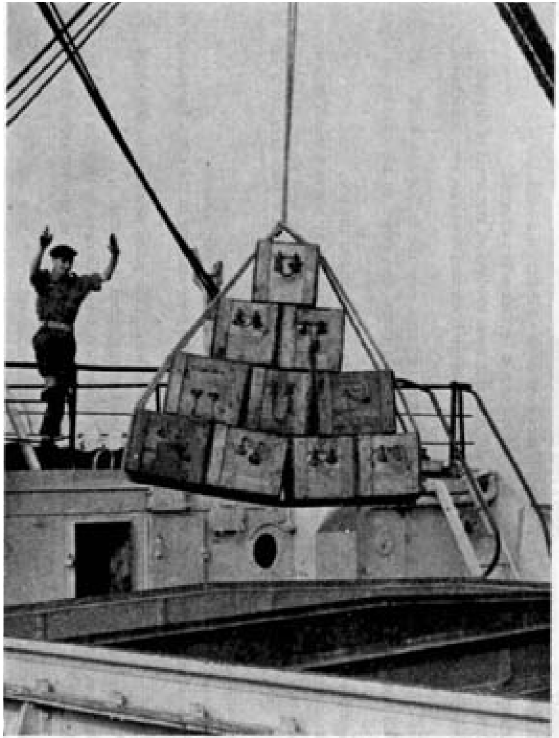


Photo 1. Hatchwayman signalling a load of boxes into the hold.

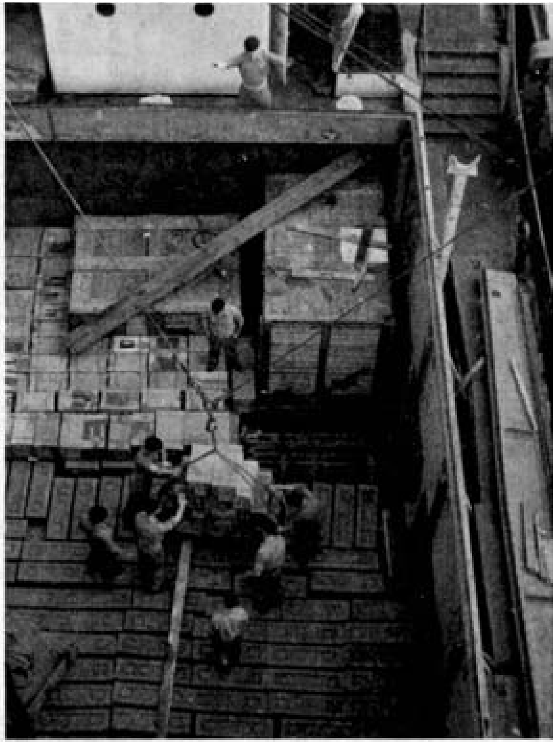


Photo 2. Stevedores steadying a load in the hold.

Loading and Unloading 1,2

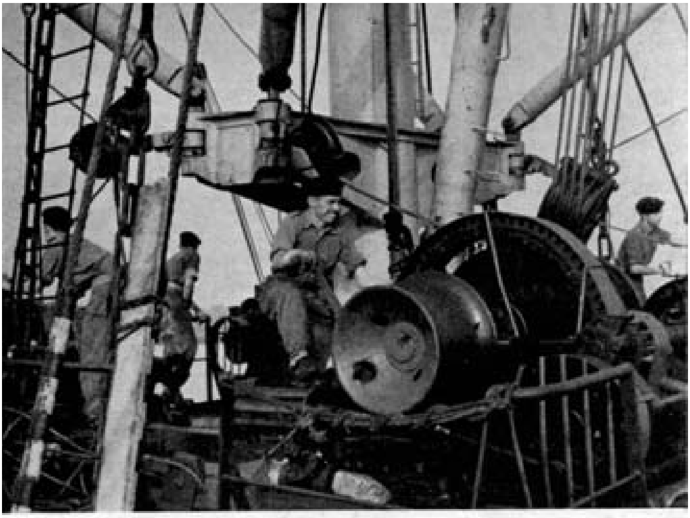


Photo 3. Winchmen at work.

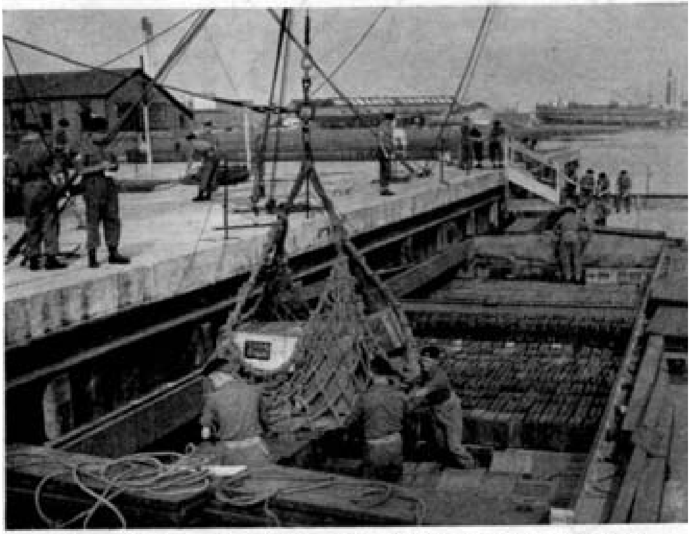
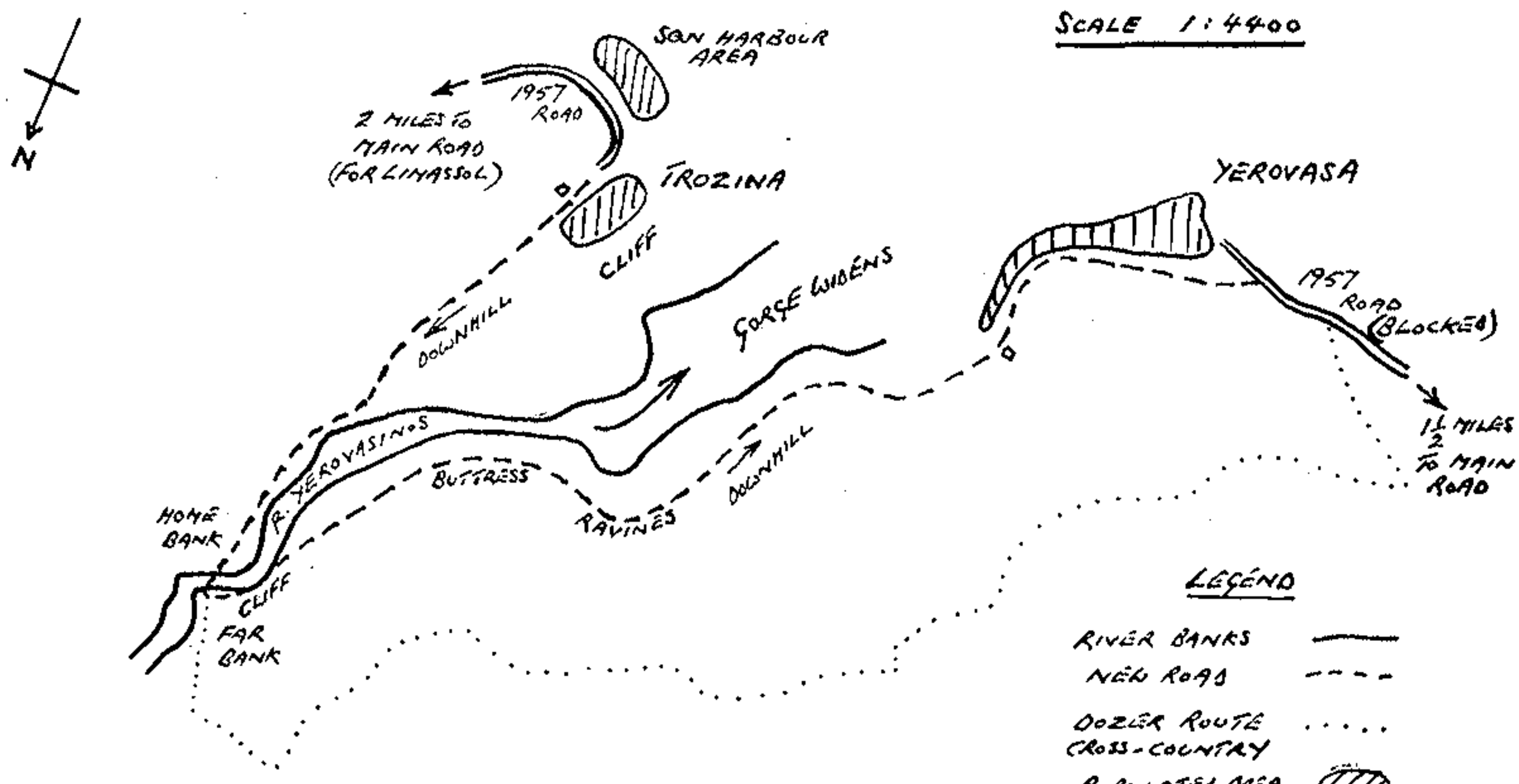


Photo 4. Unloading from a lighter on to a quay using a cargo net and board.

Loading and Unloading 3,4

TROZINA PROJECT SKETCH



The Trozina Project

A non-technical description of a two-month road and bridge project, carried out in the Cyprus hills in spring, 1958, by 37 Field Engineer Regiment.

By Captain P. M. Lucas, RE

Introduction

Visitors to RHQ in January 1958 occasionally heard pronounced the curious word "Trozina". Its mention often invoked wry smiles and sometimes frowns. It seemd to relate to an awkward problem which was about to force itself upon the Regiment.

Later the circle of secrecy widened and it was realized that a sizeable construction project was to be undertaken in the spring—the "Trozina and Yerovasa road and bridge Project". By the end of the month it was allotted to 40 Field Squadron—"The Fighting Fortieth"—which was most able to shelve its commitments and accordingly did so with speed.

The Background Story

Trozina and Yerovasa are two small and dusty villages perched just under 2,000 ft. high in a hill cleft about thirty serpentine miles north-west of Limassol. They are only 1,000 yds. apart, but completely separated by the deep gorge of the River Yerovasinos.

Yerovasa is north of the gorge, and Trozina south. Both were connected to the outside world in 1957 by 10-ft. sidehill tracks, so that motor vehicles could be used in place of donkeys for the distribution of their staple harvest of grapes. However, both villages send the majority of their grapes to Limassol in the south, and for the Yerovasa harvest this involved an extra 15 miles detour to the west and a different route. The only way of cutting out this uneconomical diversion was to make a road bridging the gorge and connecting the two villages so that both could use the direct route to Limassol.

This was not carried out in 1957 because of the inherent difficulties which stand out clearly when the scene is visited.

Though the two villages are so close, they are separated by nearly 500 ft. in height. Trozina stands on a jutting precipice overlooking Yerovasa and the river, which is 50 yds. wide at this point and turns into a raging torrent at certain times of the year. When the river dries to a trickle in summer a zigzag path cut in the rocky promontory allows men and donkeys access from one village to the other.

Such was the problem put to the Army and responsible for the frowns in Regimental Headquarters.

The First Visit

The first visit to Trozina showed that two courses were open. The least attractive was to bridge the Yerovasinos at the foot of the cliff, and build almost the whole road on the Trozina side of the gorge. The average slope upstream of Trozina on this side was about 30 degrees. It was easier to bridge here because the bed of the river was accessible from the Yerovasa

Photo 1. A view of the majority of the road work. The light area is all fill from road excavation.

Photo 2. An aerial view of the far bank approaches, showing the cliff which had to be cu down.

The Trozina Project 1,2

side, but floating trees and scour might endanger the bridge. Also, the road would obliterate some very fertile grazing land, and a massive hairpin bend would be required half-way along the road.

The local people pressed to have the road built high up on both sides of the river, where the slopes were so steep that the land was subject to landslides and was valueless. This provided the second and most orthodox course—to bridge the gorge upstream about half-way between the levels of the two villages. Here the gorge narrowed to just over 100 ft., and dropped sheer the same distance to the river bed. The problems in this case were the great slopes of the hillsides which plunged to the edge of the gorge. On the Trozina side they were still about 30 degrees, but on the Yerovasa side they averaged over 40 degrees. This presented a formidable bridge site excavation problem, quite apart from difficulties in road construction. These difficulties reached their limit over the last 100 yds. of projected road to the Yerovasa end of the bridge. Here the approach was along the vertical wall of the gorge, and the project entailed cutting down the whole cliff by an average of nearly 50 ft. to establish a bench for the road.

It was only too apparent why the 1957 road scheme neglected to connect the two villages. Opinion as to the feasibility of completing the project in reasonable time flourished most strongly in RHQ, where there was a store of experience gained in Burma and Italy. Elsewhere such convictions were less evident. The author was compelled to make a rapid choice when a three-page written order arrived, starting with the words "You are required to produce a written engineer project to cover the construction of the Trozina-Yerovasa road and bridge."

A class 24 EWBB was specified, and a road formation width of 18 ft. plus room for drainage and a safe edge. The whole of 40 Field Squadron and the plant troop of 18 Field Park Squadron were available for about five weeks.

Reconnaissance and Planning

The specified maximum gradient of 1: 15 determined the approximate road alignment. Reconnaissance was aimed at surveying the proposed alignment and bridge site to produce excavation figures, and consideration of plant routes and a harbour area.

No. 1 Radar Air Survey Liaison Section, sharing the same Camp as the Regiment, agreed to do the survey. After two trying and at times dangerous weeks in the rain, the survey team produced an alignment elevation with sections every 100 ft., and a detailed survey of the proposed crossing site. There were only two gaps in the survey, at places where even the local goats had not been able to walk. Calculation showed that over 75,000 tons of rock would have to be removed. Disposal of it along most of the 2,000 yds. length of road would be simple—it would fall straight into the gorge.

To avoid the large excavation required for a normal launch, it was originally planned to launch the 130-ft. bridge by cantilever launch using 40,000 gallons of water as a counterweight. This method was only discarded when it was appreciated that the work involved, including construction of Braithwaite tanks on a 20-ft. structure with inverted rollers bearing on the top chords of the bridge, would take too long. The orthodox launch was just as quick as the rock was found to be mainly soft, and the excavation for the launching site made a better approach to the bridge. The planned depth of excavation on both banks at the crossing place was nearly 60 ft.

Plant routes to the project presented a considerable problem. On the Trozina side plant could be motored on its tracks the last two miles to Trozina, and about 600 yards of road had to be made to reach the projected bridge site. But on the Yerovasa side the situation was very different.

The 1957 approach road to Yerovasa was found to have been washed away or removed by landslides in seventeen places during the previous winter. There was no possibility of a diversion as the hills were mountainous for several miles to each side of this road, and even footpaths did not exist. It was essential however to get plant working early on the Yerovasa side, to excavate the far bank bridge site. In addition the majority of the roadwork—1,400 yds. along 35–45 degree slopes—lay on that side.

Hence it was essential to start the project by rebuilding the 1957 road to Yerovasa. But the problem was not solved by this step alone. It was also necessary to blast and doze a route across steep hills and narrow ravines to reach the vineyard perched over the bridge site, and to blast a track down to it through overhanging rock ledges.

Finally, the only hollow in the hills which could be used as a squadron harbour area—after a track had been cut to it—was found to be at Trozina. This was sited around the only spring in the area.

The plans eventually embraced the usual multitude of requirements. A minimum of six dozers, three compressors, a concrete mixer and a grader were required. A demolition team was allotted to support each dozer. The bridge was ordered up from Tripoli. Twenty tons of concrete had to be mixed for the bridge foundations, and half carried across the gorge on a 320-ft. aerial ropeway. At least 3 tons of explosives were required, and a large quantity of compressor tools. Camp structures were ordered and a detailed plan of the camp made to allot the crowded space. Transport was strictly curtailed owing to lack of parking space. Plant was to work 10 hrs. a day, 6 days a week, and the task would take about seven weeks. The project ran to thirty-seven cramped pages, and a lot was left unsaid.

Reaching the Bridge Site

As the main interest in this project centred around the appreciation and planning, it is not proposed to describe in detail how it was carried out. But an outline might be of some interest.

A week before the start a Families Day was held at Trozina on a Sunday, so that the wives of men employed on the task could see how their husbands were to spend the next few weeks. This was accompanied by rain, and the valley looked its worst, emphasizing one aspect of an open-air life.

Early in April the project began. A troop was sent round to open up the road to Yerovasa, and the rest of the squadron and plant troop moved into harbour at Trozina. While blasting and dozing was starting on the far route, squadron morale rose quickly as quick progress was made on the Trozina side.

Light relief was provided the first day. A certain house lay on the road alignment, and had to be removed. On the approach of a dozer the owner, who had postponed activity to the eleventh hour, summoned friends and began to dismantle it stone by stone. When it was pointed out that time did not permit such leisurely progress he seemed surprised, but agreed. A few minutes later the house was transformed into two piles of stone, and the dozer operator had achieved every plant operator's secret ambition.

After this feat a small crowd assembled and followed events with keen interest, led by the Village Mukhtar who had several near escapes when he became too closely identified with the project. However, he maintained his interest throughout, although attempts at conversation in any language invariably failed.

On the second evening a dozer appeared over the Yerovasa bridge site, and reached the site itself after two more days and a near escape on the rock ledges. A large demolition programme removed several huge rocks—some as big as the dozer—which were strewn over the site, and cutting down began on both sides of the crossing place.

The gorge was soon filled with rock to a height of 80 ft., and nearly offered an opportunity for a centre pier launch. However, after 7,000 tons of rock had gone in under the bridge centreline the fill began to spread and the idea was abandoned. The river still flowed steadily through the base of the fill without carrying it away.

Some Diversions

By this stage the Squadron Camp was well set up. It was sited in one of the most attractive settings in Cyprus, the view was compared with some of the best in Scotland, and the open-air life and constant mountaineering made everyone fitter.

In the evenings a cinema screen was set up against the hillside and four different films shown each week. On Sundays the Officers Mess held open house and entertained guests to "lunch with a view". This was rarely marred by the river which flowed through the dining tent whenever there was a storm over Trozina.

EOKA kept away, although a certain terrorist called "Four-fingered Charlie"—the result of a premature demolition—was known to be in the offing.

One serious diversion was the result of continuous cracking of the welds in the blade yoke of all dozers of a certain make. The rock took a steady toll of these machines, and most evenings saw welding in progress until midnight. It was universally suggested that a welding set be made organic to the tool-kit of this dozer. The welding set generator ran for many nights next to the wall of a house; it was not until the end of the project that the owner mentioned that he "slept" with his head a foot from the wall in question.

As the working day was long, and the heat exhausting, any diversion appealed to a hardened sense of humour. The most crucial was provided when a helicopter hovered for a time over a large demolition which had been initiated a minute or so before its appearance. It was waved away by a sea of arms with a minute to spare. On another occasion some traditional satisfaction came from the reactions of a well-known Civil dignitary, who on a visit was invited to "press the button" and was startled by the explosion of a 300-lb. charge amplified by the megaphone shape of the valley below. A steady source of more unkind amusement was the regular appearance of Cypriots on the unfinished route, who had heard that there was now a road to Limassol through Yerovasa, and were greatly disappointed when the road was found blocked by huge rocks or a hillside.

Bridging

After the bridge site was completed and the Trozina approach road ready for traffic, bridging began in the fourth week when the foundations of reinforced concrete were laid. Meanwhile the bridge arrived piecemeal in overloaded civilian trucks carrying unusually assorted loads. The stores site was cramped, and formed by levelling some fill from excavation.

In the fifth week the bridge was built and jacked down in just over a day, and the squadron was honoured by the visit of the Chief of Staff, GHQ, MELF, Major-General R. E. Lloyd, OBE, DSO. In addition the Chief Engineer Cyprus, the Commissioner of Limassol, and the Administrative Secretary of the Cyprus Government watched, and a film unit of the Cyprus Television Service filmed the construction while other photographs were taken for *Soldier* and *The Sphere*. The Sappers were visibly awed by the interest taken in their work, and played their parts well.

Roadwork on the Yerovasa Side

There now remained a large amount of roadwork on the far side of the valley, to link the bridge with Yerovasa. This work proved much more difficult than anticipated. Frequent landslides made dozing dangerous, and the ground was intersected by narrow ravines crossing the road alignment. As these ravines were filled they discharged the fill into the river below. In addition the steep sided spur between each pair of ravines was an obstacle which had to be dozed away after a difficult climb up to the start of the cut. A great deal of blasting was required to bring down overhanging rock, and more than once a dozer slid sideways down a ravine and was only saved by cool nerves.

However, by now the Plant operators were not to be put off by any natural obstacle, and the landscape was basically altered in a week.

At this point it was necessary to say farewell to Major John Parfect, who commanded the squadron. He was leaving for England and a golden bowler hat, and was dined out of the Trozina Mess with considerable ceremony and wine. Rather like a farewell from Hawaii, a special song was composed to a Calypso-style tune, and sung by the officers. Describing the highlights and humour of the Trozina project, it devoted a verse to the less successful exploits of every officer, the SSM, etc. The refrain at the end of each verse —"Down in Yerovasa where the vines all grow, that's where you'll find him" —summed up our sentiments after weeks of balancing on the edges of the gorge.

No sooner than the OC had gone, difficulties increased. A certain massive buttress of rock, sloping at over 45 degrees and unsurveyed, resisted all attempts to get a pilot track round it, and it had been necessary to run the pilot track over the top. This upset the gradients along the whole Yerovasa road, and it was essential to cut the buttress down from the top. Two Size II dozers worked nearly twelve hours a day for a week, and finally reduced it to a suitable level after removing an extra 30,000 cu. yds. of rock. This output was achieved by using an unusual dozing technique. The bench was kept sloping very steeply down towards the edge of the gorge, and the dozers worked down this slope. The steep gradient increased their output by a half, and they pushed huge quantities into the gorge with every cut.

The next problem came with the start of "Operation Kingfisher"—the search for Colonel Grivas in the local hills. This required considerable plant effort, and some of the Project dozers were withdrawn for it. By now Sundays had gone by the board, and dawn-to-dusk working started. The project time was extended by one week.

As the road was pushed on to Yerovasa, work on the Trozina side was completed. The bridge approaches were improved, and the bridge painted and given a wearing surface. The Camp was dismantled in stages, and large quantities of stores returned.

At last the road came to Yerovasa. Consternation was caused when it was cut through the vineyard overlooking the village. Huge rocks slid down on the village, which had to be partly evacuated and guarded while the work was in progress. The width was slightly restricted to avoid burying the nearest houses, and finally the 1957 track terminal was reached and a junction made. Now it only remained to grade the surface and fix marker stones along the route to prevent traffic straying into the gorge. When this was done at the end of eight weeks, it was time to go.

Departure

The last tents and structures were now taken down and plant convoys sent off. Efforts were made to restore Trozina to its original state, but there were still signs that its population had been quadrupled for a time. The departure was made with genuine regret after a long stay in such pleasant surroundings, but satisfaction was felt over the size of the impression the Regiment had left on the area. A hundred thousand tons of rock had gone into the gorge, and the path of the river diverted in more than one place. The new road left a massive scar along both hillsides, and the first traffic had begun to take advantage of the shorter route to Limassol.

Lessons Learnt

A few of the lessons learnt during the Trozina project may be of some interest.

One good dozer operator was found to produce more than twice the output of an average performer. As a result the best operators tended to be overworked when time was short, but this was offset by careful attention to their needs. Cold drinks, tea and snacks were taken to the machines, which were occasionally stopped for inspection or a brief substitution of operator.

It was found that the dozers could work over ten hours a day if their maintenance was efficient. A team spent all its time inspecting machines and carrying out all maintenance, mainly after dark or very early in the morning. This worked well.

It was also found that dozer outputs tallied very closely with the figures given in RESPB. These figures were, however, comfortably exceeded by using the "exaggerated crossfall" technique mentioned earlier in connexion with cutting down the large buttress.

Finally, to prevent damage to machines and speed output, demolition teams to support the dozers were found to be essential and were always at hand. They had prefabricated charges ready and were called forward whenever a dozer struck a really hard stretch of rock and was making little headway. In a few minutes a few small shattering charges would be placed on the offending boulder or sheet of rock, and it would be sufficiently cracked up for the dozer to proceed. This treatment, apart from being quick, avoided the use of compressor tools, and the problem of access for compressor equipment. It was found that blasting was reduced over-all because the dozers were able to tackle all the rock-cutting work themselves with this assistance.

Field Engineers in Atomic Warfare

By Major A. E. Younger, DSO

The statements and opinions expressed are of the author alone

Editor's Note:—This article was written before the E-in-C's Conference in November, 1958, but was not published earlier due to lack of space.

Introduction

In a previous article, *RE Journal*, March, 1959, an attempt was made to outline the effects of atomic warfare on demolitions, on crossing water obstacles and also to outline the protection aspect for individual Sappers. The object of this article is to consider the effects further, in order to fill in a background against which troop training on atomic warfare can be practised in field engineer units.

Engineers in Advance and Attack

For some reason a misconception lies in some people's minds concerning the tactical use of atomic missiles. The error is in the assumption that if an air-burst weapon is used, there will be no residual radioactive contamination to affect our own occupation of the area under the burst. This is not so. One effect of the neutron bombardment produced by an air-burst atomic explosion is to induce gamma activity in the ground immediately below the burst. This neutron induced gamma activity (NIGA) is contained in a roughly circular area around Ground Zero and its strength decreases quite rapidly as the distance from Ground Zero increases. However, in the centre of the area, the amount of NIGA depends on the height of burst and may be heavy.

The rate of decay of NIGA depends on the chemical composition of the contaminated soil, and is high compared with the decay of fall-out. The "half-life" of NIGA may be taken as about fourteen hours.

These facts relate to any atomic airburst, but their most important implication is on the tactics to be employed by troops attacking behind atomic fire support. However, the effects of possible errors due to inaccuracies in the means of delivery must also be considered. After a round has been fired, observers will have to plot the actual GZ and height of burst and to relay this information to the commander. Then, as the yield of the weapon will also be known, a calculation to estimate the extent of NIGA could be made. Knowing this, the commander could then modify his plan if necessary.

A secondary problem arises in calculations of this kind which, whilst of no direct concern to engineers, is worth bearing in mind. Observers should not have too much difficulty in plotting the actual GZ by a simple intersection of bearings. However, to plot the height of burst will not be so simple. An error in height of 500 ft. subtends an angle of less than one degree at 5 miles and it may prove no easy task to judge the centre of a fireball to this accuracy without previous experience.

Mine Clearance. The impact of NIGA on engineers will be mainly in its effects on mine clearance.

The chances of an atomic explosion destroying a mine will depend on the design of the mine and fuze and its depth below the surface, as well as on its distance from GZ. If these facts are unknown before an attack, no estimate of probable safe lanes could be made. Even if they are known, it may be dangerous to make predictions, unless the mines are laid on or very close to the surface. For instance, anti-personnel mines may be neutralized over a wide area, particularly if the outside casing is inflammable or if they are operated by trip wires. However, it should not be assumed that the blast effect will uncover the more deeply buried mines, although their sensitivity may be increased. Any estimate of probable casualties will be hazardous.

To summarize the situation. If the enemy have laid mines in front of a position that is to be attacked by a tactical atomic missile, the commander of the assaulting troops may direct his armoured forces over GZ. Troops on foot or in soft-skinned vehicles should follow a route that avoids GZ and the area immediately round it.

If it then becomes apparent that mine clearance must be undertaken, speed will be vital. Without speed the enemy may be given a chance to plug the hole punched in his defences. The mobile armoured forces that are directed over GZ must have equally mobile and armoured Sapper support to maintain their advance.

Work in Contaminated Areas. Apart from the problem of mine clearance, engineers may be called upon to maintain, clear or construct routes and airfields which have been contaminated.

The first problem will be that of dust. Human breathing organs provide a most effective filter to solid particles, so there does not seem to be a danger of fall-out acting as a poison gas. The danger from dust is that it will tend to collect on clothing and the body, so that a man may carry with him a source of radiation. Quite heavy doses from external sources are required to cause casualties, but even a small one from a source inside the body may prove to be lethal. Therefore personal cleanliness, as a form of decontamination, will have to be enforced, particularly before meals.

In war the alternative to dust is mud, which raises a similar need for decontamination. Respirators will not be necessary, although rain will be suspect as bringing contamination until proved clean, so a face cover of some sort will be required.

It is hoped that the new combat clothing will be issued to all ranks; the coarse surface of battle-dress must be the worst possible for collecting dust, mud and rain.

As well as the danger from radioactivity inside the body, there will be the external danger from fall-out. A man working or moving on foot obviously will be exposed to a source that is lying on the ground. Vehicles will give some protection, so plant operators would only receive about half the dose of a walking man. The last war habit of putting filled sandbags on the floor of vehicles will reduce the dose still further, to about a quarter.

This amount of protection may suffice in areas that are lightly contaminated. It will not suffice when contamination is heavy, for instance, shortly after the explosion of a ground burst missile. Many areas will, of course, be by-passed and left to decay, but if work has to be done in them, only armoured engineers could accomplish it. The latter might enjoy a protection of over 95 per cent, whilst they remained inside their AVREs.

Mechanical vehicles suffer from the disadvantage that dust adheres readily to oily surfaces. Therefore, if radioactive particles are not washed off them at the earliest opportunity, vehicles will expose their occupants to unnecessary doses.

The possibility of using remotely controlled plant for really urgent tasks in highly contaminated areas is attractive at first sight. However, it requires enough skill to operate most types of plant by hand, and it would be most difficult to operate them through remote controls. Also, the research effort and cost required to produce a guidance system would be considerable.

Use of Local Materials. Without some knowledge of the enemy's plans it will be difficult to forecast the chances of any local resources being contaminated. If his plan is that the vast majority of his atomic strikes will be air burst the chances will be small, but if any appreciable number are ground burst the chances will be great. Any enemy strike must be assumed to be ground burst until the contrary is proved. If it is, casualties will be heavy amongst men handling local materials unless thorough precautions are taken. Since field engineers are more concerned with local materials than other arms, there is a strong case for a special issue of detection equipment to them. A scale of one instrument to each section would not be excessive.

It is clearly prudent to teach all Sappers how to approach contaminated materials, and the possibilities and difficulties of decontamination. No practical or theoretical exercise concerning the handling of resources that have been stored in the open should exclude this aspect.

ENGINEERS IN DEFENCE AND WITHDRAWAL

Protection. In any type of war, a commander who moves into a new area has to decide how much protection he will require his unit to make for itself, in the light of the current threats from the air and ground. The degrees of protection vary. When the danger is slight and the time spent in the area is likely to be short, only simple alarm posts are required. When enemy ground and air attack is probable and the time to be spent in the area is likely to be long, full-scale defensive works may be desirable.

In an atomic war the threat of nuclear attack adds a new factor to the commander's appreciation. If he orders his men to spend a certain period digging in and generally preparing their own protection, he is, in fact, ordering them to expose themselves to the chance of becoming atomic casualties for that period. Any time spent by a unit in uncamouflaged efforts to protect itself is dangerous.

Under nuclear war conditions the priorities for protection become:—

(*a*) Camouflage and concealment.
(*b*) Flash protection.
(*c*) Protection against ground attack.
(*d*) Protection against nuclear radiation.

It is difficult to overstate the importance of camouflage and concealment, which merit great sacrifice in other directions.

Applying this to engineer units, it seems that the maximum amount of work should be done by night and the minimum by day. Dumps should only be open for receiving and handing out stores by night. This is easier said than done. It requires a lot of imaginative training before individuals, and particularly commanders, can work by night and sleep by day without exhausting themselves.

However, it must be realized that the concealment effect of working by night will be offset, to some extent, by the increased danger of blindness from flash. It is difficult for anyone who has not seen an atomic explosion to appreciate the effect of flash on the eyes at night. Descriptions of explosions as being so many times brighter than the sun mean little to the layman. A paragraph in *The Times* of 13 August 1958 was perhaps more descriptive:

"An explosion of a nuclear warhead on Johnston Island startled thousands of residents in Hawaii (700 miles away). The explosion also temporarily blinded passengers and crew in an Australia bound Quantas airliner 800 miles away."

Translating these distances to Europe, the residents of Venice would have been startled by the burst of such a warhead over London, and aircrews over Danzig and Vienna temporarily blinded.

Troops will not be exposed to effects over such great distances, as they will be screened by folds of the ground, woods and buildings. However, they must be warned of the danger of flash and trained not to expose themselves to it unnecessarily, for instance when resting.

This subject of protection is one that will require the attention of commanders whatever their men are doing. When applied, for instance, to river crossings it may lead the engineers to forsake the obvious bridge sites and go for unlikely and more difficult sites, using obvious ones for active deception. This would entail more effort and equipment, but it could make all the difference between success and failure.

Minelaying. The main object of minelaying is to deny mobility to the enemy. In a nuclear war, when the very survival of units may depend on their ability to move, mines could be a decisive weapon. However, they are two-edged and, if they deny ground to the enemy, they may do the same to friendly units.

It must be expected that minefields will be required. At the time that they are being laid, the troops so employed will be exposed to attack.

In addition, the area selected for a minefield may be found to be contaminated by fall-out. If this is the case, calculations to determine the time a man can work in the area must be made in the usual way, and protective clothing used.

Both these factors point to the use of mechanical minelayers. These increase the speed of laying and protect the operators from the effects of contamination on the ground to a certain extent, by reducing the dose rate to about one quarter if floors of vehicles are sandbagged. They would also save individual casualties by eliminating the need for men to tramp on, and possibly handle, radioactive soil. However, they are not a complete answer, and probably never will be, since they are so dependent on the type of ground.

General Points

Organization. In all phases of nuclear war, commanders will be faced with the fact that, while conventional weapons will kill individuals, atomic weapons will kill units. This implies that if a Division has three brigades, each requiring one engineer unit, the CRE should control four such units so that he can replace one immediately if it becomes an atomic casualty. This in turn indicates a major reorganization of units, but it need not mean an increased manpower bill. A solution is to revert to a basic regimental organization instead of independent Squadrons, but with HQ Squadron doing all administration and Field Squadrons being really enlarged Troops. These Field Squadrons could be capable of living in the field for long periods only if attached to another unit, such as a Battalion or Brigade HQ, for administration; just as a troop can exist now if necessary. The men saved by the removal of three present Squadron HQs would be partly absorbed by creating the HQ Squadron. There would still be enough left over to form the working members of a fourth Squadron.

The disadvantage of such an organization is that the Squadron loses flexibility. Today it can, with the comparatively minor addition of a Park Troop, go anywhere in the world at short notice and tackle a great variety of tasks. If it is reorganized by having its headquarters cut down almost to the present Troop headquarters size, only the Regiment has this flexibility. Another disadvantage is that a Regimental organization might induce concentration in an unguarded moment.

The advantage is that, in conditions where two or three brigades are fighting together, the number of working Sappers is almost doubled. This is an advantage we can ill afford to overlook in these days of manpower shortage and possible atomic war.

If no such reorganization is undertaken, the problem of planning survival is more difficult. It must depend mainly on individual Squadron Commanders dispersing their troops, so that the unit as a whole is never located in such a way that it can be completely disorganized by one atomic burst. This type of dispersion is not unusual for a Feld Squadron supporting a brigade in actual operations, in fact it is almost normal, but it is much more difficult for Corps or Army units to achieve. If all the Troops in a Squadron are employed together on one large task, the only protection will come from deception and surprise.

Water Supply. The contamination in water will be from fall-out which contains insoluble matter, so a settling tank will deal with it. However, the tank itself must be under cover and rigid precautions must be taken to prevent recontamination from the dust of passing vehicles.

Clearly tests must be done to find out whether the existing field equipment needs modification in the shape of extra or different filters. Existing equipment is becoming out-dated in design, for instance a plastic bubble would be an improvement on the "S" tank, and we should drink from flasks instead of mugs. But even after taking every precaution, a water point operator should test the water taken off with an instrument capable of detecting small quantities of radiation. He may also have to check over all water trucks and containers before they are filled, sending away any that are found to be contaminated.

Luckily water point operators usually develop a high sense of responsibility. This sense will need to be supported by an equally high degree of training and standard of equipment, if they are to avoid inadvertently causing numerous casualties.

Armoured Engineers. The engineer with his tools, equipment (including RADIAC instruments) and stores, moving in an armoured vehicle, has the answer to many of the difficulties of fighting a nuclear war. His wireless communications alone give him a marked advantage, whilst his armour will enable him to move freely in areas where unprotected troops would quickly become casualties. Experiment and experience should be applied to enable him to do as much work as possible from inside his tank. For instance, the removal of collapsed structures from roads in a NIGA area is a most likely requirement. The demolition gun could cut the obstruction into parts, but a grapnel and winch are required to remove them.

The advantages and economies in concentrating armoured engineers into specialized units are great, particularly in peace-time. In nuclear war, however, there will be no foreseeing where or when they will be needed. It seems therefore that the time is coming when we must overcome the difficulties and allot some armour to all field units.

Conclusion

All aspects of field engineering will be affected by the use of atomic weapons. Of all the implications, two stand out. First, that ground contaminated by radioactivity will never stop well-trained men under determined leaders from completing their task. Second, that camouflage and concealment will hold the balance between success and failure. These should include all aspects of deception, such as alternate and dummy positions, and should be co-ordinated at all levels of command.

Finally all engineer commanders must be able to advise other arms on the very extensive engineer implications of a strike or movement through a stricken area.

Some Ideas for a New Field Squadron

By Major J. D. Townsend-Rose, MC, RE

Once again, a new Establishment for a Field Squadron is in course of being promulgated, and Lieut.-Colonel Willison's article[1] prompts one to consider what the next change should be. Many traditional units have had drastically to change their ideas, and in many ways the same applies to the Field Squadron. Now that the Divisional Engineers have returned to an organization similar to that of the last war, with three independent Field Squadrons integral with their brigade groups, let us analyse, first, the task of the Squadron.

Tasks of the Field Squadron

The all-embracing slogan, "Help the Army to live, move and fight" is too general, applying as it does to the whole Corps. The tasks can better be summarized thus:—

(*a*) To give Engineer advice to Brigade and Battalion Commanders.

(*b*) To carry out Engineer Reconnaissance and pass back information.

(*c*) To move with the Brigade (or parts of it) and supply trained troops for Engineer tasks as and when required.

(*d*) To supply Engineer tools and equipment as and when required.

(*e*) To defend itself if necessary.

To do these tasks, with the minimum Logistic support and with the maximum speed and efficiency, the Squadron must have the following characteristics:

[1] "Future trends for Field Engineers", *RE Journal*, June 1958, and awarded the Montgomery Prize for 1958.

(*a*) It must be able to move with the troops it is to support at all times; whether in Armoured or Soft vehicles, in whatever phase of war and in whatever conditions of terrain; and to move by air and sea.

(*b*) It must have its sub-units organized ready for the most likely tasks, but be sufficiently flexible to adapt its organization to fit in with all possible tasks.

(*c*) Its transport must be kept to a minimum, and special equipments and plant must be held ready for speedy dispatch to the place required.

(*d*) The troops (all ranks, including the Squadron Commander!) must be well trained in all tasks they are likely to perform.

Disadvantages of the Present Field Squadron

The existing establishment has many disadvantages, some of which are undoubtedly due to financial restrictions; but forward planning may help to overcome these restrictions when the time comes, which will be in 1961–62, when the new model Army comes into being. At present, the snags are:

(*a*) Many Engineer tasks, due largely to the increasing use of machinery, do not require as many men as they used to. A troop of thirty working numbers including Junior NCOs is adequate for Minelaying, Minelifting, building and continuously operating all current rafts, building Heavy Girder Bridges up to 100 ft., and so on.

(*b*) The 3-tonner is unsuitable as a section truck. It is difficult to camouflage, slow moving, heavy on petrol, takes up too much shipping space, not conveniently air-portable and altogether too big for its task.

(*c*) Each troop has one armoured section. In the event of needing more than a section at one time there is no "armoured troop" organization, no officer available to command it; the armour is wrongly distributed and awkward for the Squadron Commander to handle; the armoured sections have no central body responsible for their training, or for maintenance of their vehicles.

(*d*) The plant is widely dispersed—a Light Wheeled Tractor in each troop (again, no central training and maintenance organization), two Medium Wheeled Dozers in Squadron Headquarters, and all the rest in the Field Park Squadron. It is unlikely that all three Light Wheeled tractors would be in use at the same time, and those not in use will be an encumbrance to the field troop.

(*e*) There are insufficient sub-units in the Squadron. It has been accepted that a Commander can manage up to five sub-units (of the American "Pentomic" formations) and has been tried in practice in a Field Squadron (see *R.E. Journal*, June 1958, page 185). A brigade group has four major units; troops of the Field Squadron should match this organization.

(*f*) The troop carries too many little-used stores with it at all times. Until recently, Squadron headquarters too has held some tons of stores, which in peace-time have stayed on the shelves for years on end.

Proposals

The disadvantages of the present organization, outlined above, could be overcome in the future without much difficulty, and the following solutions are given—their lettering matches up with those of the previous paragraph.

(*a*) Reduce the section to two NCOs and eight men. This is more in line with the Infantry section, more in line with the tasks sections are nowadays required to do, and gives a fair proportion of NCOs.

(*b*) Mount this smaller section in a smaller vehicle. At present the most suitable truck is a 1-tonner, but something more on the lines of the Long-Wheel-base Landrover is envisaged for the future; the LWB Rover, however, has a body only 6 ft. long, and some 8 ft. are required to accommodate four bottoms on each side (the eight sappers in the section). This truck would tow a ½-ton trailer for the section's kit and the minimum of section tools. For want of a better name, call it the Extra-long Wheel base (ELWB) ¼-tonner.

(*c*) Have one Armoured troop, with each of its three sections in one APC. This troop can either be used *in toto*, in support of an armoured Regiment; or in sections with armoured Squadrons (RAC); or alternatively, sections could be attached to normal Field Troops who are supporting an Infantry battalion which also has an Armoured Squadron in support. Its establishment must be the same as a field troop, and the smaller sections will fit in an APC.

(*d*) Concentrate all plant in a plant troop which would normally move with Squadron HQ, and would not need to be as self-sufficient as the field troops (e.g. no cooks). This would provide an officer responsible for all plant, including any attached from the Field Park Squadron, and he should also take compressors and the Welding trailer under his wing; water supply equipment, including a Paterson Trailer would be his also.

(*e*) Have in the Squadron a total of five troops; the Plant Troop and four others, of which one only is armoured in the Infantry Brigade and three are armoured in the Armoured Brigade. This will bring the squadron back to about 120 working numbers, overcoming any disadvantage apparent in para. (*a*) above. The establishments of field and armoured troops must be the same in all respects except that APCs are used instead of the section ELWB ¼-tonner and trailer; a scout car for the troop commander; and one of the men in each section must be a wireless operator, as the armoured sections should be in wireless communication with their troop commander.

(*f*) The stores must be centralized more, and it would become normal practice for a troop to draw stores from the SQMS for any particular task. In this way the troop stores truck could be reduced in size to an ELWB ¼-tonner. This would also be the one truck in the troop with a winch and could go wherever the sections went without difficulty. It would not have a trailer normally, but would be available to tow compressor or welding trailer when required, or any of the other troop trucks which might break down.

A Proposed Establishment

These proposals are beyond the scope of amendments to existing establishments, so a new, theoretical war establishment has been prepared, which will give a firm basis for argument. That part of the Establishment normally headed "Distribution of Rank and File by trades and duties" has been omitted to save space, but the rest has been put in a shortened version of the familiar form.

To satisfy the pound-of-flesh men, Peace Establishment could omit completely a field troop in the Infantry Brigade (and Corps Engineer Regiment) and omit an armoured troop in the Armoured Brigade, with conseqently large savings; but transport, weapons and equipment must also be omitted, as there is no spare manpower for looking after them.

A Proposed Field Squadron

(i) Personnel	Squadron HQ	Plant Troop	Four Troops each	Total Field Squadron
Officer Commanding (Major)	1			1
Second-in-Command (Capt.)	1			1
Troop Commanders (Capts.)		1	1	5
Liaison Officers (Capts. or Subalterns)	2			2
Total officers	4	1	1	9
Squadron Sergeant Major	1			1
Squadron Quartermaster-Sergeant	1			1
Troop Sergeants (three may be S/Sgts.)	1	1	1	6
MT Sergeant	1			1
Clerk Sergeant	1			1
Signals Sergeant	1			1
VM Sergeant	1			1
Total WO, S/Sgt. and Sgts.	7	1	1	12
Corporals	4	4	4	24
Lance/Corporals	4	5	4	25
Sappers	22	20	32	170
Total R and F (RE)	30	29	40	219
Attached:—				
RAPC Clerk (Sgt.)	1			1
ACC Cooks (Cpl.)	1			1
(L/Cpls and Ptes)	3		1	7
Total attached	5		1	9
Total all ranks	46	31	43	249

(ii) Transport	Sqn. HQ	Plant Tp.	Four troops each		Total Field Sqn.	
			Fd. Tp.	Armd. Tp.	Inf. Bde.	Armd. Bde.
Motor Cycles	4				4	
Truck ¼-ton GS, Long Wheel Base	2	4	1		9	7
Truck ¾-ton GS, ELWB.			4	1	13	7
Truck ¾-ton GS, ELWB. with winch			1	1	4	
Truck 1-ton GS FFW	1				1	
Truck 1-ton Water	1				1	
Truck 3-ton GS Cargo	3	1			4	
Truck 3-ton Cargo W/W	1	1			2	
Truck 3-ton Binned	1				1	
Truck 3-ton Office	1				1	
Trailer ½-ton Cargo	1		3		10	4
Trailer 1-ton Cargo	3	1			4	
Trailer 1-ton Water	1				1	
Scout Cars	2			1	3	5
Carriers, APC, wheeled				3	3	9
(iii) Towed Equipments						
Trailers ½-ton, welding		1			1	
Water Purification sets, trailer-mounted		1			1	
Air Compressors, 75 cfm, ditto		2			2	
(iv) "C" Vehicles and Plant						
Cranes, 4-ton hydraulic, truck-mounted		2			2	
Tractors, wheeled, medium		2			2	
Tractors, wheeled, light earth moving		2			2	
Tractors, wheeled, fork lift, cross-country		2			2	

A PROPOSED FIELD SQUADRON—*cont.*

	Sqn. HQ	Plant Tp.	Four troops each		Total Field Sqn.	
			Fd. Tp.	Armd. Tp.	Inf. Bde.	Armd. Bde.
(v) Weapons						
LMGs, .303 in. (including those for scout cars)	4	1	3	4	18	20
Rocket Launchers, 3.5 in.	1		1	1	5	

(vi) Organization

(This Table is intended merely as a guide to Officers Commanding Units)

SQUADRON HEADQUARTERS		
Command Group		
¼-ton LWB		OC, Dvr. Op. (L/Cpl.), Spr.
Scout Car		LO, Dvr. Op., Bren Gun
Scout Car		LO, Dvr. Op., Bren Gun
Four M/Cs.		4 DRs. (incl. 1 Sgt. and 1 L/Cpl.)
Office and Signal Group		
1-ton FFW.	1-ton Tlr.	2 IC, Sgt., Dvr. Op., 3 Wrls. Ops. (incl. 1 Cpl.)
3-ton Office		Sgt. Pay Sgt., L/Cpl. 2 Sprs., Dvr., Bren Gun
Adm. Group		
¼-ton LWB	½-ton Tlr.	SSM, Cpl., Spr., Dvr., Bren Gun
3-ton Cargo	1-ton Tlr.	SQMS, Dvr. (G1098 Stores), Rocket Launcher
3-ton Cargo	1-ton tlr.	Cpl., Dvr., Spr. (G.1098 Stores)
3-ton Cargo	1-ton Water Tlr.	Cpl. and 3 Ptes. (Cooks), Dvr.
1-ton Water		Sgt., Dvr.
MT Group		
3-ton binned (FAMTO)		Cpl., Dvr., Spr.
3-ton Cargo W/W		Sgt., Dvr., 2 VMs. (incl. 1 L/Cpl.)
PLANT TROOP		
Command and Adm. Group		
¼-ton LWB		Tp. Comd., Dvr. Op., Spr. (VM)
¼-ton LWB	Welding Tlr.	Sgt., Cpl., Dvr., Spr. (Welder) Bren Gun
Tractor Section		
Two Med. Wh. Dozers		2 L/Cpls., 2 Sprs. } includes one fitter
Two Lt. Wh. Tractors		2 Sprs. } (hydraulic)
3-ton Cargo	1-ton Tlr.	Cpl., Dvr., Spr. (acts as tender to Tractors)
Crane Section		
Two 4-ton Cranes		2 L/Cpls., 2 Sprs. } includes one Fitter
Two Fork-lift Trucks		2 Sprs. } (hydraulic)
Water and Compressor Section		
Two ¼-ton LWB	Two compressor Tlrs.	1 Cpl., 1 L/Cpl., 2 Dvrs., 1 Fitter
3-ton Cargo	Paterson Tlr.	1 Cpl., 1 Dvr., 2 Sprs.
FIELD TROOP		
¼-ton LWB		Tp. Comd., Dvr. Op.
¼-ton ELWB		Tp. Sgt., L/Cpl., Dvr., Spr., Cook Rocket Launcher
¼-ton ELWB (W/W)		Cpl., Dvr., Spr. (Tp. Stores), (incl. VM)
¼-ton ELWB	½-ton Tlr.	Cpl., L/Cpl., Dvr., 8 Sprs., Bren Gun
¼-ton ELWB	½-ton Tlr.	Cpl., L/Cpl., Dvr., 8 Sprs., Bren Gun
¼-ton ELWB	½-ton Tlr.	Cpl., L/Cpl., Dvr., 8 Sprs., Bren Gun
ARMOURED TROOP		
Scout Car		Tp. Comd., Dvr. Op., Bren Gun
¼-ton ELWB		Tp. Sgt., L/Cpl., Dvr., Spr., Cook, Rocket Launcher
¼-ton ELWB (W/W)		Cpl., Dvr., Spr. (Tp. Stores), (incl. VM)
APC		Cpl., L/Cpl., Dvr. Op., 8 Sprs., Bren Gun
APC		Cpl., L/Cpl., Dvr. Op., 8 Sprs., Bren Gun
APC		Cpl., L/Cpl., Dvr. Op., 8 Sprs., Bren Gun

For these ideas to be put into practice, it is only necessary to secure the following:

(*a*) A suitable "ELWB" ¾-ton truck. As an interim measure only, the existing type of 1-ton truck could be used.

(*b*) A suitable compressor on a ½-ton trailer.

(*c*) Acceptance of a suitable 4-ton crane.

(*d*) A trade of "hydraulic fitter".

There are clearly a large number of changes in this proposed establishment, some of which deserve brief mention, if only to point out their *raison d'etre*; they are of course my own ideas and may give rise to discussion particularly among those now fortunate enough to be serving in a Field Squadron. Perhaps it should be pointed out, here, that the squadrons of Corps Engineer Regiments should be identical with those of Infantry Brigades, and would be interchangeable with them.

The Field Troop

All in lightweight trucks, all of one make, easy to camouflage; this means that the crew of a section truck can de-bog it easily, and the whole troop is air-portable without losing its transport. Fewer men, but sufficient for most modern tasks. Fewer stores to deal with, but these are readily available in Squadron H.Q. Three spare "hooks" for towing. Easily changed over to an Armoured Troop.

The Armoured Troop

By reducing the size of the section and the number of tools carried, it will fit into one APC, which makes for ease of control. The troop can be detached complete, or sections allotted to field troops if required. Troop commander has a scout car instead of a ¼-ton truck, but two ELWB ¾-tonners are kept for stores, troop sergeant, cook, etc.—one of these has a winch.

The Plant Troop

The Troop Sergeant's truck tows a welding trailer, the welder travels with him; if necessary, a field troop can take over the man and the trailer. The Sergeant has a truck because he will have to visit any site where his plant is working, taking fitter, spares, fuel, etc.; the same applies to the Troop Commander.

Light wheeled tractors are reduced to two, and concentrated with the medium wheeled dozers—thus all are ready to be sent where required instead of being forward with field troops all the time and possibly being unused. A 3-tonner and trailer are there for carrying the extra front and rear end equipments for all four tractors—the 3-tonner could, in emergency, carry a light tractor. The two cranes are hydraulically operated semi-slewing 4-ton machines, weighing under 10 tons and capable of a road speed of 25 mph. They are 4×4 and already exist in prototype for civil purposes; they can do almost all bridging tasks, but at a reduced efficiency. One of the operators in this section is to be trained in hydraulic fitting.

The compressors should be an improved version of the Airborne compressors, to give about 75 cu. ft. a minute which is enough for most purposes —one heavy breaker or two light picks. They are mounted on a ½-ton trailer chassis and are towed by ¾-ton LWB trucks which contain all the tools necessary, together with a trained operator. The present establishment which puts the compressor behind a tipper, the tools in Squadron HQ and the operator in the field troop, is untidy to say the least, and is one reason why our compressors, tools and operators seldom all work.

The 3-ton truck and Paterson trailer may seem an innovation, but they were used together as far back as 1943, during the campaigns in North Africa and Italy; the corporal and sappers are well trained in the operation of a water point, and the truck carries all stores including S-tanks, spare pumps, etc., for a water point. They normally need the help of a Field Troop to "set up shop" but once installed they run the water point on their own. The present establishment for the Field Park Squadron shows the trailers held by Stores troop, moved about by a 10-ton tipper and no operators, which is why Paterson trailers are so often "off the road".

I have put in the fork-lift trucks to show I am broad-minded.

Squadron Headquarters

The Squadron Commander has a ¼-ton truck; if he wants to put himself in armour, he can use one of the LOs scout cars, which can also be attached to the Field troops (with the LOs) if needed. The 2IC will probably complain about travelling in the wireless truck, but he can argue the toss with the SSM if necessary. The office truck is a great boon, even if a little expensive, and will be in good company near Brigade HQ. The SQMS has only three 3-tonners, but some of his stores (e.g., compressor and welding kit) have gone to the plant troop. The cooks truck tows a water trailer and there is a water truck also (which should have a towing hook) so that there are two ways of getting water and delivering it to the troops. The Cook Corporal has three cooks to help him as he may have to relieve one in a Field Troop, and anyway has to cook for those of Plant Troop who are not out with Field Troops—a possible total of 77 all ranks.

There is no HQ troop officer; either an LO or the 2IC perform this function, when the SSM needs help.

There are two trucks for MT duties—one is binned for the FAMTO (a vital part of any independent squadron) and the other for general stores, recovery and petrol collection.

Conclusion

To sum up, here are the advantages achieved by the proposed Establishment over the present one.

Mobility.

Field troops all in light trucks; air portable; easily hidden.

Smaller, compact, sub-units.

Fewer 3-tonners, 1-tonners and trailers.

Flexibility.

Armoured troop can operate as a whole, or in sections.

Troops can change from Field to Armoured if the Squadron changes its role.

Fewer stores in troops, but sufficient held in Squadron HQ.

Plant can be allotted as required, without withdrawing from troops.

Troop has spare hooks for compressors, welding trailers, etc.

Compressors linked to tools and operators.

Less dependence on the Field Park Squadron.

Economy

Increased capability at very small extra manpower.

Less petrol per squadron-mile.

Less initial cost.

Less shipping space.

Capability.

Self-contained brigade water point is carried.

Reduction in light tractors offset by centralization.

Cranes enable squadron to do bridging tasks without help.

Fork lifts for handling defence stores, etc.

Small increase in working numbers.

Increase in number of sections, hence in number of tasks that can be undertaken simultaneously.

There are also, I suppose, disadvantages; but I'm selling, not buying.

Postscript

Since this article was written, 1 Inf. Div. have published some results of their Mobility Trials. It is clear that the present Field Squadron could not readily be adapted to a role where trolleys or mules are the only transport, nor can it be put on a ¼-tonner basis. The proposals outlined above, however, are readily adaptable to enable part of a Field Squadron to take its place with a highly mobile, airportable, independent Battalion Group.

Maralinga

(*The Land of Thunder*)

By Lieut.-Colonel H. Harvey-Williams, RE

One hears little or nothing of the Services' effort at Maralinga, the Ministry of Supply Atomic Weapon Range in South Australia, other than an occasional press cutting to the effect that a device has been exploded there. I, therefore, give a brief description of the Range and an outline of the part played by the Services.

The Range

"Maralinga" is an Aboriginal place name, named long before an Atomic Range was thought of, and means "Land of Thunder", a coincidence but nevertheless true.

It comprises a village, an air strip, one of the largest strips in Australia, and the Test Area. The whole area is leased from the Australian Government by the Ministry of Supply but remains Australian Territory, the security of which is entirely the responsibility of the Australian Government.

Maralinga village, which is 13 miles north of the railway halt "Watson" on the Trans-Australian Railway, is approximately 600 miles west of Adelaide. The construction is almost entirely of Bristol type aluminium hutting which has proved extremely satisfactory, and with the exception of extreme high winds which lifted some of the roofs no problems have been experienced. An aerial view of the village is shown on page 176.

The amenities comprise a modern swimming pool, cinema (free twice nightly) recreation rooms, cricket, football (Australian and English Rules).

Photo 1.—Maralinga Village "Main Street", H.Q. offices in left foreground.

Photo 2.—Maralinga, looking north to "Forward Area".

Maralinga 1,2

The whole area is a geologists' paradise as not only is it situated on the edge of the Nullabor Plain (a Latin name meaning "treeless") but it shows over an area of 400–450 sq. miles, traces that the sea once rolled over it. These are in the form of little cliffs, shells and wave marks for hundreds of miles inland. Bones have been found which it has been said by experts in fossils and the like to be those of diprotodons. Occasionally blow holes are to be found like ancient craters which blow and suck alternately on an approximate eleven-hours cycle. The blow is sufficient to keep a straw hat suspended in the air. Approximately 150 miles south-west of the Range an underground lake of nearly a mile in diameter 400 ft. below ground level can be found, and to everybody's amazement it is as near fresh as one ever gets water in that area.

The Test Area

The Test Area starts 15 miles north of the village and stretches east, north and west of that point. All main roads from the railhead at Watson to the furthest experimental area are tarmacadam.

Divisions of Responsibility

The Range is Commanded by a Colonel of the Australian Army. His Deputy is the Range Chief Engineer and Senior British Officer, a Royal Engineers Lieut.-Colonel. The numbers involved are approximately 50 per cent from each country. There is no differentiation between the two in any way and groups etc. are made up from either country. Added to this they comprise Navy, Army and Air Force of both countries, thus any member of the Unit may be working side by side under or in charge of personnel from another Service or from either country.

The organization is known as "Maralinga Atomic Range Support Unit" (MARSU) and in general the groups are made up as follows:—

HQ Group (Administration etc.)	All six Services
Stores Group	RAF, RAAF
Electrical and Mechanical Group	RN, RAN
Field Engineer Troop	RE, RAE
MT and Plant Workshops	REME, RE
Transport Group	All six Services

Refrigeration. Nearly all laboratories are air-conditioned and a large number of refrigerators are installed for scientific use.

Plant. Over 100 items of Engineering Plant and 450 vehicles of different types are held. The very fine soil–dust commonly known in Australia as "bulldust" makes maintenance of all moving equipment extremely difficult.

The Test Area. Engineering commitments in the Test Area are extremely varied and change according to the type of rounds to be tested and as required by the Atomic Weapon Research Establishment and to some degree by the Target Response effort.

They are mainly of a Field Engineering nature such as dozing and grading miles of instrument lanes, blowing holes for underground instruments, revetting, traversing, erection of towers etc., tasks which normally in peace-time, Sappers do not get in the vastness as they do at Maralinga.

It is not possible for security reasons to go into any detail of the actual employment of the Royal Engineers in the forward area, but in the 1957/58 Series "Antler" the Engineer Troop received glowing commendations from the U.K. Atomic Energy Authorities for the magnificent part they played in making the "Antler" trials a success.

Engineering Problems

By far the most important Engineering Problems on the Range are those of water and power supply. These are so closely knit that one is dependent on the other and, being the life-blood of the Range economy, both are essential. For instance, the effluent from the sewage system is pumped back to the Cooling Tank and used as a spray over the Cooling Fans.

A general description of the installation is as follows.

Water. The water requirement is for an approximate daily consumption of 60,000 gallons of fresh water. To achieve this nearly three times as much raw water from some eighteen bores between 300 ft. and 1,500 ft. deep is required. The bores are scattered around the village in a radius of approximately ten miles all driven by electrical impellor type pumps which feed into a 250,000 gallon tank situated just outside the main power station. It is then pumped through a double set of triple effect evaporators, into a cooling tank and thence to the various points as required. Hot and/or cold water is circulated through all buildings, swimming pool and showers in all living accommodation. Further, high purity water is also produced for the Technical Laboratories, but most of the decontamination is done with raw water.

The following Table I gives a typical analysis of bore water.

TABLE I

Typical Analysis of Bore Water

	Grains per gallon	Assumed Composition of Salts	Grains per gallon
Chlorine, Cl.	1231·4	Calcium Carbonate	2·5
Sulphuric Acid		Calcium Sulphate	135·5
(radicle) SO_4	379·6	Calcium Chloride	—
Carbonic Acid		Magnesium Carbonate	—
(radicle) CO_3	1·5		
Nitric Acid		Magnesium Sulphate	355·9
(radicle) NO_3	Nil		
Sodium Na	748·5	Magnesium Chloride	103·8
Potassium K	—		
Calcium, Ca	40·9	Sodium Carbonate	—
Magnesium, Mg	98·4	Sodium Sulphate	—
Silica, SiO_2	—	Sodium Chloride	1902·6
		Sodium Nitrate	Nil
		Potassium Chloride	—
Total Saline Matter:—			
	Grains per gallon	2,500·3	
	Ounces per gallon	5·71	
	Parts per million	35,600	
Hardness in English degrees as follows			
	Total	507·0	
	Temporary	2·5	
	Permanent	504·5	
	Due to calcium	102·1	
	Due to magnesium	404·9	

From this Table it will be seen that the total saline content at 35,600 p.p.m. is higher than that of normal sea water which is about 30,000 p.p.m. and that the hardness is almost entirely permanent.

Evaporators. The evaporators were designed to produce 32,000 lb. per hour of distilled water which is equivalent to 60,000 gallons of water per day. The purity of the final product has been as low as 15 p.p.m. total dissolved solids as NaCl, which is perfectly suitable for drinking purposes.

Greatest difficulty was experienced during the 1957 trials in producing sufficient water for the needs of domestic and scientific requirements due mainly to the amount of descaling of the evaporator elements which had become encrusted with calcium sulphate. The original design of the evaporators was for descaling all heating elements every 150 hours of running, but this did not in fact happen, as after sixty hours the fresh water produced fell below the economical level and therefore descaling was necessary at more frequent intervals which of course reduced production. The main reason for this was that although extensive tests were made of the properties of the raw water, evaporators are designed normally for sea water which produces scale mainly of magnesium hydroxide, whereas Maralinga water is hard calcium sulphate. Both hydrochloric acid and caustic soda were used as agents in the removal of the sulphate scale, but the more effective way was found to be subjecting the tubes to alternate heat and cold.

The cooling tower circulates approximately 27,300 g.p.h. with a temperature drop of 125°F. to 76°F.

Power. The power plant consists of two 1,000 kW. (nominal) gas turbine driven alternators generating at 6.6 kV 3-phase 50 c/s and one 500 W (nominal) diesel alternator set generating 415 V 3-phase 50 c/s.

The two gas turbines were designed for the main power supply, and the diesel, which is radiator cooled, is an emergency set only. Through a step-up transformer, the diesel alternator can be run in parallel with the turbines should the need arise.

Each gas turbine has an axial flow type compressor of thirteen stages, the blades of which are manufactured from stainless iron, the outlet pressure being two atmospheres.

The compressor turbines are two-stage with a full load speed of approximately 11,500 r.p.m. direct coupled to the compressor, the blades of which are made of nickel chromium alloy.

The major problem in the power supply was that of producing to the scientists a stabilized supply which is absolutely vital to their needs.

A ventilation system, air-washing and cooling plant is also installed to keep the turbine room in a reasonable condition and under a slight positive air pressure to stop dust being drawn into the turbine room.

Steam. Steam raising plant consists of two waste heat boilers augmented by the heat from the gas turbine exhaust to generate steam at 100 lb. sq. in. gauge. These boilers are equipped with auxiliary oil firing so that the steam output of 10,000 lb. per hour each can be maintained whatever the load on the turbines. If necessary, the boilers can be run entirely on oil firing, but of course could not maintain the steam output at such a high level.

The whole water and power system is very similar to that used on board a ship, but of course much larger, and therefore the operation is carried out most efficiently by RN and RAN personnel on a normal ship's watch duty.

The South Georgia Surveys

By CAPTAIN A. G. BOMFORD, MA, ARICS, RE

SOUTH GEORGIA is an island in the South Atlantic, the most northerly of the Falkland Islands Dependencies. It is about 120 miles long and about fifteen miles wide; about two thirds of the island is covered in ice, and many glaciers flow into the sea. Between the glaciers rise high mountains, Mt. Paget reaching 9,625 ft., and twenty-five peaks exceeding 6,000 ft.

It is an important base for the whaling industry. Three factories are maintained by British, Norwegian and Argentinian companies, and the annual catch is worth about £3 million. There is no permanent population. In winter, the shipwrights overhauling the whale catchers, and the British Magistrate, with his postmaster, customs officer, policeman and their families, are the only inhabitants. In the spring, transports bring in the whaling crews, and the summer population rises to about 2,000, of whom about six may be women. The factory ships come down to collect their fleets of whale catchers, the catchers from the shore stations go out to hunt, and the surrounding seas are full of shipping. The interior of the island remains deserted. No one has cause to go there, and with the crevasses, rock falls, white-outs and sudden blizzards, an inexperienced traveller would soon die. On a clear day, the mountains are dazzlingly beautiful, but more usually they are shrouded in cloud. The whalers go to the island to work hard and make money; except for local ski runs in winter, no one leaves the stations.

The coastal waters of South Georgia are full of hazards, and fog comes down with startling suddenness. Since the war, at least four ships have been lost or badly damaged. In 1931, the Admiralty published a chart of the island made from running surveys at sea. It is remarkable how much the surveyors got right, but it is extremely difficult to chart the indented coastline of an unmapped island merely from the sea, and though the whalers carried the chart, to lay off a course on it was to invite disaster, and it was seldom used. Once the interior of an island has been mapped and its peaks triangulated, it is comparatively simple for hydrographers to fix the offshore hazards and soundings. But until 1951, no one was prepared to survey the interior of South Georgia.

In 1951, Duncan Carse took a party of six men to the island on his own initiative, and began the survey. For a first season in the interior of an inhospitable island, they achieved a good deal: they heighted many of the main peaks, and mapped about 40 per cent of the island. Equally important, they learned how to travel and live in the interior. The country is too rugged and because of the bad weather progress is too slow for dogs to be economic, but most of the glaciers are linked by snow cols, and by man-hauling sledges, with an occasional backpack, it is usually possible to force a route.

Duncan Carse led a second expedition of four men in 1953. The party was too small, unhappy, and one member was sick throughout. Two good journeys were made, but little of permanent value was achieved. But by 1955, Carse knew exactly what he was about. He wanted a party of eight, with two competent surveyors, and five experienced mountaineers. By chance, he met the then Director of Military Survey at a cocktail party; the wheels began to turn, and a few months later I was appointed his first surveyor. The second surveyor, Stan Paterson, was a statistician by profession, but he had run the subtense traverse across Greenland with Simpson in 1953, was a first rate mountaineer, and could handle a theodolite or computing machine with equal facility.

Carse's pre-expedition administration was of the highest class, and he fitted us out superbly. We sailed from Newcastle on 25th August, 1955, in the whaling transport *Southern Opal* and arrived off the island in a crystal clear, rose pink dawn a month later.

Our task was not to survey as much of the island as we could to some preconceived standard of accuracy. It was to complete a map of the whole island as accurately as we could in the time available. The weather in South Georgia is extremely bad. In summer it is not cold by polar standards—the daily range in temperature was often from 20° to 40° F. As a result, everything gets very wet. The prevailing westerly winds frequently reach gale force, and over the mountains produce violent blizzards and dense cloud. We were out sledging for a total of 140 days. On only thirty-nine days was it sufficiently clear to do any surveying; on another forty-six we were able to travel, and on the remainder we were confined to our tents.

The triangulation presented few technical problems.* Time was the great enemy. Good visibility seldom came and soon went. There was no question of climbing difficult peaks for sport; our mountaineering skill went into judging from below which peaks could be most rapidly climbed, and in quickly overcoming unforeseen difficulties during an ascent. Whenever it was possible, cramponing up steep snow was undoubtedly the quickest way to climb.

A Tavistock theodolite, its tripod, small survey gear, climbing gear, a torch, food and warm clothing were carried up each hill, and these ascents were hard work. I had had visions of myself as a sort of gangling intellectual being hauled ignominiously up vertical pitches on a taut rope. But my companions were so wise and so expert in all mountain craft that I had absolute confidence in their leadership and ropework, and followed without a qualm wherever they cared to lead. In some mountaineering circles I believe it is considered bad form to climb so fast that one perspires. My only contribution to our mountaineering technique was to kill this tradition stone dead, and we climbed fast, to the limit of our strength.

A full set of observations from a summit took about three hours of intense work, during which the party had to keep warm and in its right mind. The best plan was to strip off as soon as one got to the top, put a dry sweater on next to the skin, pile on every item of clothing one had, and make sure one was tightly sealed at wrist, waist, ankle and around the face. Silk gloves with woollen wristlets were very good for working in. Snow blindness was a very real danger to the surveyors, as we had to raise our goggles in order to read the theodolite. On the first journey Paterson was black blind and in great pain for three days; after which we were more cautious.

As often as not, the clouds came down before we had finished our observations, and we had to climb down to our skis and ski back to camp in thick mist. Even for the expert, downhill skiing with an awkward load in nil

*For survey techniques, see *Empire Survey Review*, January and March, 1958, "The Survey of Santa Georgia" by Bomford and Paterson.

visibility is an irregular method of progression, and for the inexpert it is quite startling. It was often difficult to find our way back to the tents, but only one party ever failed to do so. Having got up at three in the morning, had a hard climb, almost perished with cold on the summit, and had a difficult return journey in the mist, I know of few greater pleasures than to regain camp about 2 p.m., brew up, and fall snugly asleep till hoosh time.

There was no question of scaling peaks to build cairns, and we observed to the natural tops of the hills, most of which were sharp and made fair targets in the theodolite. Without artificial beacons, triangulation accumulates error very quickly, but there is no harm in this provided that one keeps everything under control by measuring frequent bases and azimuths. Instead of measuring one base, one azimuth and one star-fix with extreme accuracy, we controlled the triangulation with eight bases, eighteen sun azimuths and seven star fixes, with accuracy sufficient for our purpose. Nearly every peak we climbed was of course a first ascent, and theodolite observations were taken from a 7,205-ft. peak, now Mount Paterson, which is at present the highest point reached on the island. In all, 240 trig points have been co-ordinated, and another 170 points heighted.

Mapping the ground between the trig points was a more difficult problem. There were no air photographs, because the mountains are too high, and there was no airfield, no aircraft and no money. There was barely sufficient clear weather for us to complete the triangulation, let alone to try to plane table. A photo-theodolite had been used in 1951, but the photographs had turned out badly, and the angles proved inadequate. Individual ground photographs are almost impossible to compile into a map. We solved the problem by photographing complete 360-degree panoramas at every survey station, and in addition drawing panoramas in great detail on squared paper, with the help of a prismatic compass. When the main angles at a station had been observed, horizontal and vertical angles were taken with the theodolite to as many points of detail as possible and recorded on the panorama. It was then possible to fix and height any point observed from two stations, and intervening detail was drawn in from the photographs.

We carried a Facit computing machine with us on the sledge journeys, and did as much computing and drawing as possible when held up by bad weather. We drew on transparent astrafoil, a medium that does not distort even when immersed in water, and which is quite impervious to repeated applications of india rubber. We had much leisure when lying up—I think we all read both *War and Peace* and *Anna Karenina*—and the surveyors were very pleased to have something interesting to do. But in any case it is good practice to compute and draw as soon as possible. Snags invariably crop up, but if the field work is still fresh in the mind, it is astonishing how often they can easily be settled from memory. It is also a good insurance against the loss of the original field books, and against their unintelligibility. Moreoever, while it is not unknown for officers to be given leave to accompany expeditions, it is much rarer for them to be given leave on their return in order to work up their results. When we disembarked in London on 6th May, 1956, preliminary drafts of our mapping had already been drawn.

We lived in small two-man tents (Photo 1) which just accommodated two men in their sleeping bags, on lilos, with a ration box and cook box between them. The tents were designed to be pitched tail into wind, when they will withstand any gale. It was better to camp in the middle of a glacier, where the wind would be strong, but steady in force and direction, rather than under the "shelter" of a hill, where the wind is apt to come in great gusts in each direction in turn. This lesson was well learned on the first journey during a storm in which two of our four tents split or carried away, and we had an uncomfortable night with eight of us crouched in two tents. Later we took to pitching tents in pairs, head to head with a sledge between them (Photo 3), and successfully rode out an eight day blizzard in this way.

The rations were good and admirably packed, twenty-four man-days being packed in a plywood box weighing 56 lb. gross. The ratio by weight of food to packaging was the highest then achieved; there were only three tins in a box, everything else being vacuum packed in plastic bags. Half the boxes contained pemmican and half meat bar; the latter was the more popular, but a mixture of the two is best. Originally there was no tea or coffee in the ration, merely cocoa and lemonade crystals. The effect of a brew of tea in the middle of a day's man-hauling is quite astonishing, and after the first journey this serious omission was put right. A cup of coffee once a week is also a delightful luxury. We cooked on primus stoves and carried candles, neither of which can easily be bettered.

Despite every economy in weight, we were heavily laden, and on the first sixty-day journey, with a depot to lay, we started off hauling 3,000 lb. Uphill, we could generally only haul one of the three sledges at a time, and progress was slow at first, speeding up as the depot was laid and food and fuel consumed. Back packing was happily both infrequent and brief, as we then had to relay about six times. The sledges themselves weighed only 70 lb., but were an awkward and unpopular load.

On the last journey, it was still hoped that an ascent of Mt. Paget could be included in the survey programme. We sledged off along a familiar route, and as we reached new country, a clear day dawned. A discussion took place (Photo 3) as to whether we should occupy a couple of survey stations, or sledge on fast to the foot of Mt. Paget. The snow was icy hard, and it was decided that five men would be able to haul all three sledges, while a survey party climbed a 5,471-ft. peak. As the survey party set out, we noticed with some misgivings that our skis were leaving no tracks whatsoever, and from below we could see plumes of snow blowing off our summit. It turned out to be one of the most unpleasant stations I have ever observed, but we persevered and obtained many angles into the new ground. The weather steadily deteriorated, and by noon it was obviously high time we were off the mountain. We dropped down fast to our skis, and found them just before the mist rose over them. We then had a somewhat worrying journey. We could not see fifty feet; there were no tracks, and though we knew more or less where the other party were heading, we did not know where they had camped. The only guide we had was the slope of the ground beneath our skis, the times we had taken on the morning journey, and our compass. The slope became too steep, we found ourselves among crevasses, and were obviously off route. However, we were not too concerned. No survey party ever went out without food and spare clothing, we had our skis and ice axes, and could build an igloo and pass a night in reasonable comfort. The wind was in the east, where it seldom stayed long, and when it reverted to the west, we could expect an hour or two of good visibility. We ski'd on for two hours, spread out so that we could just see each other. The glacier began to dip down off the edge of the plateau towards the sea, and we began to edge more

Photo 1. Mount Spaaman, 6,367 ft., from a camp on the Neumayer Glacier at about 1,800 ft. This was the first major peak climbed in 1955 and it was for a short time the highest hill to have been climbed in South Georgia. Ice and rock rumble down this cliff all day, and the way up is along the top of the ridge from the right.

and more to our left, when there was an instantaneous rift in the clouds, and we had a glimpse of a single peak, which we recognized. We took a compass shot to where we thought we had seen it, did a small sum, and set off on a new course hard left. Five minutes later, two peaks appeared for a moment, and we felt much cheered. A piece of lavatory paper scurried across the snow in front of us, and then we saw footprints. They were apparently going the wrong way, but while we were discussing the implications of this, Paterson suddenly saw the tents half a mile away, and we were soon home, morale sky high, very pleased with ourselves.

This happy state did not last long, as the tents were deserted. We did not worry much at first, and as little had been unpacked, began to organize the

Photo 2. Smillie Peak, 5,798 ft., seen on our first journey from the centre of the Kohl-Larsen Plateau, about 2,800 ft. Our camp on our last journey shown in Photo 3 was about halfway between the ledges and the col to the left of Smillie. The survey party's unpleasant station is along the ridge to the left, just out of the picture; the peak on the right was the one to appear momentarily out of the mist; and the deserted camp was at the foot of Smillie's right-hand spur.

Photo 3. Early morning on the Kohl-Larsen Plateau. The mists are clearing, and the centre group, Dr. Warburton, Duncan Carse and the author are discussing the day's programme.

The South Georgia Survey's 2,3

Photo 4. Returning from a survey station at a height of about 4,500 ft., cramponed and roped, carrying the theodolite and its tripod. The distant hill on the right of the photograph is Mount Paget, 9,625 ft., the highest point in the island.

Photo 5. Setting up the theodolite on Start Point, 96 ft., and apart from the smell one of our pleasanter stations. Gentoo penguins are incubating their eggs, quite without fear, full of curiosity. It was impossible to clear a space for the instrument until one person picked up a bird, another removed its egg to a convenient distance, and the first replaced the bird upon it, where it remained, quite contented.

The South Georgia Survey's 4,5

camp. But the wind steadily increased, the mist was as thick as ever, and no one returned. Soon we could neither see nor hear each other fifty feet apart. We set out a line of skis and sticks, and found all the skis, ice axes and ropes were still in camp. We retired into the tents in an uncomfortable frame of mind.

In the morning, the gale had shifted to the west, and there was still no visibility. But at 3 p.m. it eased sufficiently for us to start digging out a sledge, and at five o'clock we set out with one sledge and two tents, ready for any eventuality. At dusk, we espied a black speck way out on the plateau. It turned out to be a dead whale bird blown inland in the gale. We camped.

At dawn, we decided we must retire to the nearest whaling station and seek help. We returned to the deserted camp, loaded the theodolites, observation books, diaries, cameras and other valuables on two sledges, and set off down the glacier, eyes skinned. The surface was good, it was down hill, and the three of us were able to pull two sledges at a good speed. At 4 p.m., about eight miles out from the whaling station, a helicopter rose from the coastal hills, flew jerkily towards us up the glacier, circled and put down. Keith Warburton, the expedition doctor, stepped out, and we were certainly pleased to see each other.

It was hard to say who had been the more worried. The others had realized we should have difficulty in finding camp, and had gone out to look for us, and been unable to find their own way back. They had very little food, no climbing gear, and no extra clothing. They had spent a miserable night in a crevasse, and in the morning decided that wind or no wind, without food, they must set out for a whaling station while they were still strong. They had had a nightmare journey, crossing the crevasses with linked arms, without skis, in the wind and mist. However, with the weather clearing in the afternoon, they got in after dark, very tired. One of the factory ships was in harbour, and had agreed to its helicopter going out to search for us. Flying a helicopter among cliffs and mountains in high winds is a risky business, and the pilot had not felt justified in setting out until the late afternoon.

Little time now remained before our departure for England, but a survey party returned up the glacier, observed at a second station overlooking the new ground and salvaged everything of value from the deserted camp.

During the season we surveyed about 70 per cent of the island, at a scale of 1: 100,000, with 500-ft. contours. This may seem a wide interval for the scale, but the country is extremely rugged, and it gives a fair picture of the terrain. The previous expeditions' work filled most of the remainder, but about 5 per cent of the island, mostly the off-shore coasts of islands and long peninsulas, remained unseen. A map of the island in three sheets at 1: 100,000 was published by the Directorate of Overseas Surveys early in 1957.

Duncan Carse returned to the island alone for the 1956–7 season, travelled round the island with the sealers, and filled the gaps with photographic panoramas and compass controlled sketches. He also walked over the whole of the important area within reach of the whaling stations, which had not been mapped as well as we wished, and returned with 1,600 photographs, nearly all in panoramas.

Early in 1958, I received four weeks leave to incorporate this new material, and redrew the map of the whole island in colour, differentiating ice from rock. For the inexpert draughtsman, Eagle Verithin coloured pencils are quicker and easier to use, and to erase, than ink, particularly when working on astrafoil. It was a very interesting task. Previously every photographic panorama had been duplicated by a hand drawn panorama filled with accurately observed angles. Now we merely had the photographs, and a new technique was required. The photographs were first cut and cellotaped into continuous panoramas with great care. They had all been taken with the same camera and enlarged in the same enlarger, and when those panoramas that contained the whole 360 degrees of the horizon were measured, their lengths were found to agree within 1 per cent. A transparent scale was then made which read angles in degrees direct off the panoramas, and provided several trig points were visible, it was usually possible to resect the camera position, and then ray in any point required.

This is a far from precise technique; the angular scale is not constant across a single horizontal photograph, and if the camera is tilted, scale is distorted. Nor is it possible to deduce useful heights from hand-held photographs taken with an ordinary camera. But angles correct merely to the nearest degree are a great deal better than no angles at all, the method is comparatively quick, and the results, while not perfect, are far superior to mere sketch mapping.

The resulting map has now been published by the Directorate of Overseas Surveys on one sheet in four colours.* While it was in the course of production, a naval lieutenant returned from South Georgia with vertical air photos of the coast round the whaling stations taken from a helicopter at 6,000 ft. This part of the coast had been mapped almost entirely from panoramic photographs, with very few theodolite angles. Seldom can a surveyor have had his mapping tested so quickly and in such an indisputable manner. Air photos of an intricate coast line show far more detail than any terrestrial photo can do, and wherever air photos have been taken, the map can certainly be improved; but no major amendment was required at 1: 200,000, and the map was printed as originally drawn.

An interim edition of the Admiralty chart has also been published, and a hydrographic officer is now in South Georgia taking soundings and charting the numerous hazards to mariners that we were unable to fix from the land.

The cost of the 1955–6 expedition was under £5,000, for the compelling reason that no more money or credit could be obtained. To this sum should be added all that we received from the whalers, who transported us to and around the island, and whose kindness to us was very great; and also the fact that apart from the surveyor lent by the army, the members of the expedition were unpaid, though each subsequently received a gratuity of £100. It may seem odd that one of Her Majesty's Dependencies should be surveyed on such terms, but this was a private expedition undertaken on the initiative of a private individual, and each member accounted himself fortunate to be on it. If as a result of the survey a single shipwreck is averted, it will prove to have been money well spent.

*Falkland Islands Dependencies: 1 : 200,000. South Georgia. Edward Stanford Ltd, 12 Long Acre, WC2, 4/- net.

The Royal Engineers' Benevolent Fund

By the Secretary of the Fund

State of the Fund

The RE Benevolent Fund was founded by RE officers ninety years ago as the RE Charitable Fund. The change of name, which betokened a change in sentiment rather than a change of function, took place in 1943. No less than 900 regular Sapper officers do not at present subscribe to the Fund. From the viewpoint of those who manage the Fund on behalf of the Corps it is disquieting to discover that these non-subscribers, nearly half the regular officer cadre of the Corps, are mainly in the junior ranks.

In nine years' time the Fund is due to celebrate its centenary. If the present trend is not reversed before then the Fund though not extinct, will only be deriving support from a minority of the officers. It will increasingly have to rely on the funds given by earlier generations. This is not to say that the Fund has received money from no other source than RE officers. Large sums have indeed been received from war time Funds, subscribed during the two world wars, and made available to relieve the distress prevalent during the reabsorption of ex-service men into civil life.

It is, nevertheless, a fact that during the greater part of the existence of the Corps it is the officers who have provided the steady income from which the Fund has distributed its benefits. Up till 1951 these benefits were limited to WOs, NCOs and men, and to their dependants, who were found deserving of help and were in distress through poverty.

In September 1950 it was, however, decided at an Extraordinary General Meeting of the Corps to alter the constitution of the Fund to provide a section to deal with officers. The money belonging to the original Fund was placed in Trust B from which grants can only be made to Other Ranks. Trust A, for officers, has been built up since then.

Development of the Fund

At first the Fund gave attention to distressed old soldiers, or to soldiers' widows. This was natural when the only alternatives to private charity were the Poor Law or the Workhouse, which were shunned by those who valued their self-respect.

The introduction of compulsory service in the 1914–18 War led to the scope of the Fund being extended to include men of all types of engagement for service in the Corps, and not only regulars. The resultant post-war peak of demands was necessarily met from special war time sums which were made over to the Fund when the war ended.

In the period between the two world wars the Fund reverted in a great measure to its earlier pattern of action by giving priority to long service men or their widows, but not neglecting assistance for men who served for the duration of the emergency. The number of men who joined for such service was so vast that cases of distress among the survivors or their dependants far exceeded those arising from regulars. Complete statistics are not available but it is known that since the end of the 1939–45 War the number of applications has exceeded 40,000 in Trust B alone. Grants have been made in 30,000 cases but this includes second or later grants to the same applicant.

Nature of Assistance Given

It is inevitable that among such a large number of applications there should be great variety in character of the requests. This variety extends to the circumstances of the applicant as regards age, service, income, commitments, health, family and the immediate object for which help is needed.

At one end of the scale is the National Serviceman who has married early and who is quickly in difficulties through some minor misfortune. On the other hand there is the old regular soldier who is past work owing to age or infirmity, alone in the world, and striving to maintain himself on a low income. The widows of such men are in no better case. The various state benefits available for such persons are by no means negligible but they do not keep pace with the rise in the cost of living.

Between these two extremes there are a great number of men, mostly of middle age, with wives and children to support, who lose their employment owing to sickness. If their sickness is not prolonged, and they have not committed themselves too deeply to the prevailing addiction to hire purchase, they may surmount their difficulties. If the illness is a long one such as tuberculosis or nervous breakdown, or if there are complications caused by illness in the family, the sickness benefit, even when supplemented by National Assistance, is not sufficient to cover clothing replacement or other household needs. Men who have taken out a mortgage for house purchase suffer particular anxiety.

It is at such a time that a voluntary Fund can provide financial assistance and in so doing give encouragement out of proportion to the money value of the grant.

Service life has its inconveniences and occasional hardships but sickness does not cause loss of income. The resources of the Army are available to soften the blows of misfortune. The bond between serving soldiers is strong at all times, evoking in action the highest devotion, even to the sacrifice of life for others. It is forged out of discipline and strengthened by the intimate association of service life. When service with the Colours is over the association is looser but the demands lighter, asking no more than financial help for the needy. It is a paradox that while the heavy demands of active service are taken for granted the appeal to meet the lesser calls of civil life is often unheeded. Ex-Servicemen have recourse to the Ministries of Labour, of Health, and the National Assistance Board, and then to the various well known voluntary societies such as the British Legion and SSAFA who concern themselves with ex-service men and women generally. Finally, there are the Funds which have been formed to deal with Corps or Regiments.

The benefits of the Welfare State may be thought so comprehensive as to remove the need for private benevolence. But the fact that these benefits are open to all may equally be held to provide a reason for giving something extra for the help of former comrades in genuine misfortune.

The disappearance of the Fund would show that the ex-Sapper is of no further concern to his Corps. It would mean handing over responsibility completely to the State, or to other societies which take general care of service people.

Officers and men do not question the duty to help a soldier in the Unit when in dire need. They may on reflection agree that the ex-soldier has a good claim for help. Ex-Sappers outnumber the serving by ten or twenty to one but they are widely scattered as individuals. This dispersion makes it impracticable for the more fortunate ex-Sappers to come individually to the aid of those in difficulty. Help must originate from the living heart of the Corps, that is, the serving members.

Method of Operation

It may be helpful to describe the use to which the Fund puts the money placed at its disposal.

The case for helping the old soldier who has fallen on evil days after long years of service is doubtless unassailable. It cannot be denied, however, that the Fund receives many applications which are less well founded. A number of men who apply had only short service. There are others who regard a benevolent fund as a source of easy money.

Some men get into difficulties through their own improvidence or extravagance. It is inevitable that applications should often come from the less successful in life. On the other hand some men and families are the victims of an exceptional burden of mounting misfortune, which they cannot overcome without help.

It is one of the rules of the Fund that not only should its help be given in relief of distress due to poverty but the case must be deserving. It must be accepted, however, that although a fund dispensing charity takes into account such meritable features as length of service and character as well as the existence of distress, it must sometimes give greater weight to the distress and less to the applicant's shortcomings.

To ensure that the efforts of the Fund are made in accordance with its rules there is a Managing Committee representative of all branches of the Corps. This Committee has from experience drawn up guiding principles to enable the Secretary and his small staff to deal with most applications. The remainder come before the Committee for decision at its monthly meetings. No application is approved or rejected by the Secretary or Committee until there has been an investigation of the circumstances. This is carried out by a local representative of some Society with long experience of service cases. The SSAFA, Forces Help Society, and British Legion are entrusted with most of the investigations. The object of this procedure is to assess the need against an accepted standard.

It is just as valuable in rejecting the ill-founded claim as in giving timely aid when justified. These societies have thousands of workers, mostly voluntary, who are able to give advice as well as to make recommendations for financial help. Such advice may take the form of advising a man or woman who is getting into difficulties how to apply for the aid for which they are eligible. This aid may be obtainable from Government departments such as the Ministries of Labour, Health, Pensions, etc. or voluntary bodies such as the Red Cross.

It is the practice of the RE Benevolent Fund to insist that full advantage is taken of all state benefits, and of funds which exist for special objects, e.g. the care of widows, the disabled, etc. By so doing the Fund avoids acting in substitution for the State which has a far deeper purse.

If the local investigator recommends a money grant, and the facts of the case given in the report show no infraction of the Fund's rules, a grant is approved. A cheque is sent to the branch of the society in charge of the case, to be applied for the benefit of the applicant in the manner agreed by the Fund.

The Committee of the Fund claims that no deserving application is rejected on grounds of lack of funds. In practice about seven applications out of ten are successful in obtaining grants. Apart from such grants the Fund has always given help in the form of weekly allowance, to needy old soldiers with long service or to widows of such men.

The Case of Officers

Since 1951, when Trust A was formed, there has been provision to meet the needs of officers and their dependants from funds specially contributed for the purpose. Officer cases are dealt with in a manner broadly similar to that already described.

The existence of such societies as the Officers' Association and the Officers' Families Fund permits modifications in the procedure and affords opportunities for co-operation with those societies. The Officers' Association and the Officers' Families Fund differ slightly in their aims, and having been established for a number of years have helped many RE officers before Trust A was formed.

There still remains a field of action for the Corps' own fund in which it is increasingly playing a part.

Some Actual Cases

Some examples of cases assisted by the Fund may strengthen the picture of its activities.

During October 1958, the number of applications received by post was	174
In addition seventeen men called personally at the office, making a total of	191

In fifty-seven cases it was not possible to approve grants for the following reasons:—

Not recommended by investigating society or withdrawn	10
Not admissible under the Fund's Rules	15
Passed to other societies	3
Not considered to warrant assistance	29
	57

Of the cases in which grants were made, the circumstances giving rise to the applications were as follows:—

Illness of the man or his family	61
Old age of the man	21
Widows with children	8
Elderly widows	4
Unemployment	35
Miscellaneous	5
	134

Particulars of various kinds of cases are given in the following paragraphs to show the type of work which the Fund sets out to do.

Sapper A is a National Serviceman with two years service who had suffered with acute bronchitis since leaving the service and had been unable to work for the last four years. This Fund was able to co-operate with two other funds in meeting the expenses of removal of his home and family to his native South Wales where on medical advice the conditions would be better for his health.

In the case of Sapper C with six years war service not only had the man been prevented from working for eighteen months due to injury but his wife had for two years suffered from serious lung trouble. They were sending their boy to a Secondary School but were badly in need of bedding for which the Fund was able to make a grant.

Sapper D, a pre-war Territorial who served till 1946, due to illness since the beginning of the year had undergone two serious operations and was still unfit for work. Though the eldest of the four children had just begun to work, the long unemployment had led to a shortage of clothes and they had no coal.

Sergeant F as a result of mental illness had been out of work for eight months. The arrears of rent and failure to meet other debts had resulted in legal action being taken and he was faced with committal to prison for debts. This was averted by the Fund's grant and he is now receiving medical treatment.

Amongst old age cases the following are typical.

Sergeant F served from early 1914 till the Armistice, now 79. Had depended on cottage property to augment his pension. Heavy repair bills and illness of his wife forced him to give up his home and resort to National Assistance. The Fund was able to co-operate with the British Legion in providing money for clothing for the old couple.

Driver H who joined a Territorial Field Company in December 1914 was in such distress due to his wife, three sons, and a daughter all having been tuberculosis sufferers that a grant was made to permit some improvement in the home conditions.

Cases of assistance to widows with children have always been considered worthy of the Fund's attention. Mrs. J is the widow of an ex-regular sergeant who died after a year's illness which had depleted the family's resources. As she was unable to work due to chronic illness, the Fund made a grant through SSAFA for clothes for the two young children. Another of the cases dealt with was that of Mrs. K whose husband had recently died. He had five years in the Corps reaching the rank of sergeant and served in two overseas theatres. Though insurance covered the outstanding bills there were four young children to clothe. As the widow was thus prevented from working a grant for clothes was approved.

Another kind of case is that of the elderly widow such as Mrs. M whose husband completed twelve years service during the First World War, and died a few months ago. As she lives in Ireland where the Old Age Pension is only 25s. a week the Fund received a request for general help. Mrs. M has a daughter living with her but as she is disabled the widow receives little contribution towards expenses. She may in this respect be little better off than so many elderly widows who live alone and have difficulty in doing so on a pension supplemented by National Assistance.

The Fund received during October a number of applications arising from unemployment.

Sapper N, five years war service, had to give up well-paid work in a foundry in May but found himself redundant when he recovered from his sickness. The British Legion helped for a time and then passed the case to the R.E. Benevolent Fund for a grant for clothing which was approved.

Sapper P, who served in Africa and Italy and had a good testimonial has had difficulty in keeping his employment in civil life ever since he left the service. This is a feature of the building trade but in this case the results were probably aggravated by domestic friction. During October the Fund made its fourth grant to the man to enable him to make a fresh start for the benefit of the children.

Sapper R, a post war National Service man from 1951 to 1953 was called up for Suez and attributed his difficulties to failure to find work when he was released. A grant was made to encourage the man till he can get more than just casual jobs.

A different case was presented by Sapper S, a war-time National Service man who took up well paid employment overseas. Hit by a trade recession he had to return to the UK with his family, penniless. A skilled man, he soon found a job but had no tools. The Fund was able to equip him with the minimum tool kit to permit him to take up employment the following day.

A Question of Money

The total expenditure of the Fund since the last war was £253,000 up till the end of 1958. The contributions from Corps sources have been just over half this amount since grants from the Army Benevolent Fund have totalled £115,000. These grants have closed the gap between the heavy post-war demands and the normal income from the Corps. The Army Benevolent Fund grants are now being reduced and by 1970 will be so much lower than at present that it may not be possible to maintain the present scale of help without reducing capital. The Committee are strongly of the opinion that the time is far distant when reduction of capital can be adopted as a policy. They have on the contrary come to the conclusion that steps should be taken to preserve the value of the Fund's capital and have prepared a scheme for approval by members at the Annual General Meeting, designed to widen their powers of investment with a view to offsetting the effects of inflation. Concurrently the Committee hope to see an increase in the number of subscriptions received from serving officers.

The scale of subscriptions adopted at the inception of the Fund has never been raised but officers' pay in those days was a fraction of what it is today. Even allowing for changes in purchasing power the burden on subscribers is lighter now but it is not evenly spread. The Corps has many activities which attract the interest of officers in varying degree. The Benevolent Fund is the only one which offers no material benefit to those who subscribe. It does, however, give assistance to some officers and many men who have served in the Royal Engineers. If the Corps owes anything to these men it is a debt which falls equally on all officers, or on units, of the Corps.

This obligation has been met in the past by means of subscriptions, donations or legacies, some of considerable amounts, some of small sums. If all serving officers of the Corps were to subscribe it would go a long way to compensate for the inevitable reduction in the size of grants from the Army Benevolent Fund.

If subscriptions were also received regularly from units it might be possible to close the gap completely. Some units now send donations on a generous scale but the practice is not general throughout the Corps. The institution of Corps Days, church parade offerings, collections at sports meetings, or annual AER and TA camps, and unit collection boxes, are evidence of a growing interest on the part of units in the Fund. If the absence of more general support can be traced to lack of information on the Fund's task and its performance it is hoped that enough has been written to prove that it commands support from all. The Benevolent Funds of the Royal Artillery and the Royal Corps of Signals are known to be very widely supported. The Corps' care of the Sapper should not end when he doffs his uniform. The slogan of the RE Benevolent Fund is "Once a Sapper, always a Sapper."

Civilianization or the Twilight to a Military Career

By Lieut.-Colonel R. M. Power, AMICE, RE (Retd.)

In these days of "golden bowlers" and redundancy many regular officers have to face the prospects of an early retirement, either enforced or voluntary. Indeed enforced retirement whilst still comparatively young is the fate of every soldier, whilst his civilian contemporary expects to continue working until old age intervenes or he chooses to stop. The prospects are not improved for the soldier by having to change to a completely new occupation and mode of life.

Having just completed this transference from a military to a civilian life, and to my satisfaction, I thought I might try to pass on my experiences and impressions which might be of use to others likely to be in the same position.

I write essentially from the point of view of the regular officer who has failed to be born into or to have married into wealth, and therefore is required to augment his pension; and more especially for those who must continue working for many years and not just tide over a few years to complete children's education, etc. Nor does it concern those with expectations or with influential family connexions.

By far the most difficult decision in retiring is by far the simplest, namely "to go". For my part the Military Secretary's Department made the decision for me; perhaps just as well because if you have to work after retirement then the earlier you go the better. Age 45 years seems an average upper limit for most good jobs with prospects. Just look at the advertisements. Possibly one reason is that many firms nowadays have pension schemes and fifteen to twenty years is a reasonable time to qualify for pension. There has also been a change of emphasis in industry towards youth. No longer is age regarded as a necessary guarantee of experience for higher appointments. Younger men are nowadays getting high positions and they naturally prefer to have young men under them. The later you defer your retirement after 45 years the narrower will be your range of possible employment, starting with borderline industrial jobs in administrative posts and then more poorly paid jobs in charitable and likewise organizations.

The decision to retire I admit can be terribly complicated for the family man. He probably cannot afford an uncertain drop in income during the transition stage. For my part long years of overseas service had given me my fill of shootin', fishin' and huntin', yet left me unhampered with excess baggage as marriage did not come my way till just before retiring. In fact marriage even deferred my planned retirement and enabled me to qualify for maximum pension. Still I sympathize with the man with family obligations. It must be a strong temptation to prefer a few years more of certainty to the unknown. To them I say as to the prospective bridegroom—"take it like a cold bath; plunge in and get it over quickly". And preferably before you are 45. If you wait to be flung out, you will be older, more fixed in your ways and generally more difficult to place besides less acceptable.

It is important to have the right mental approach to retirement. For my part I was practically "bred" for the army from a line of military stock. My father gave me the choice between the sporting youth of a military life followed by enforced impoverished old age, or, the dreary monotonous grind of civilian youth leading to a possible wealthy twilight by which time you will have forgotten how to enjoy life. Surely the services must of necessity be a young man's profession so why all this grumbling when your inevitable fate overtakes you. After all you get a most generous gratuity and pension judged by civilian standards and you cannot all expect to be generals.

Having decided to go—or been told to get out—the next problem is to get a job. Naturally you do not want to start from the bottom like an ex-schoolboy, yet due to your lack of experience employers will be less willing to start you higher up. After all when you yourself engage staff you naturally prefer someone with previous experience even for the humbler jobs. But you are offering say fifteen years of work which at even £1,000 a year is likened to selling a commodity worth £15,000, in fact probably worth even more. Therefore you must take care and be prepared to spend money on your advertisement. The basic problem is that your field of selection is considerably reduced due to your lack of technical experience and the type of position acceptable to yourself. On the other hand there are employers, though admittedly few, who do recognize the good attributes of an ex-officer and who are prepared to train them or at least give them a chance to prove their worth. But such employers are likely to be very choosey and more likely to ask a friend for a recommendation than to risk the unknown from an advertisement. This all implies that you cannot cast your net too wide. Write to everybody and anybody you can raise the slightest excuse. Answer every likely advertisement, follow up every clue and do not be put off by snubs or refusals. It is not a bad thing to have prepared neatly typed letters ready to send off, possibly varied to suit different tastes such as pro-army, anti-army etc. Remember the recipients of your letters will be busy men, probably not interested in you except as another case so it is most important to create a good impression and make things easy for them.

Your chief asset will be your own personality and integrity as a good officer. Do not trot out the old chestnuts about man-management, willing to go anywhere, powers of administration, leadership, etc. You must try to impress your own character by personal interview if possible. It is a must to see as many people as possible; even if they have nothing to offer remember they have business friends, though unfortunately they also have relatives and children. Every interview will add to your experience and improve your interview technique. Also gradually you will form an idea as to the types of jobs which might suit you and also the salary you might expect. Therefore always offer to go and see people, even if only in the hopes of getting more introductions.

Writing direct to big firms I found generally not fruitful. A junior member of the personnel branch opens your letter. He or she probably only works to a list of vacancies and relevant qualifications. It is the personal introduction which counts. So try always to find an excuse to address your letter to someone by name. If he throws it in the waste-paper basket, no harm comes to you.

The really big problem is to know what you want. Try not to say that you are prepared to do anything—firms are not interested in fickle wanderers. Better to ask your interviewer what he has to offer and keep off the subject until you have begun to formulate ideas. Undoubtedly this is the age of qualifications and initials. Institutions and associations exist for practically everything. A sort of closed shop is being extended more and more into the professions. Practical experience is tending to count for less than a string of letters after your name. The initials will certainly gain you an interview though the practical experience may be necessary to secure the job. Unfortunately military experience does not count for much in civilian life. It does not avail much to say that you were in charge of building a road or bridges during the war or to suggest that your staff college training will be useful in civilian life. Just the same as in army, what really counts in civilian life is a knowledge of the rules, the procedure and administration involved in getting things done. In these respects there are great differences between conditions in the services and in civilian life. I say services implying pure soldiering as the Works Service and the Ministry of Supply with their civilian background of contract procedure, financial control and civilian staff do qualify as useful experience.

Many sappers have engineering degrees and others are members of engineering Institutions—such as the Civils and Mechanicals—either as the result of their own efforts or following one of the Long Engineering courses. These qualifications are absolutely invaluable. Those officers without "prospects" on retirement nor confident of achieving the rank of general should seriously consider these courses, not that I wish to encourage the army as a convenient stepping stone but what happens to you after retirement is your own affair. Failure in this respect will not earn you much except sympathy and that will not keep you alive.

Another difficulty is to decide what salary to ask for. The world loves a success story. You rarely hear of the flops and even less of the vast multitudes who fail to make the great successes and are just struggling along. This applies just as much to sport as to daily life. You hear of the left-and-right and the near par scores but not the misses and that 8 at the 17th. So take those success stories of £2,000 a year plus, and a car, etc., with the pinch of salt they deserve. There are of course many such tales, some genuinely earned, some acquired through family influence and others with a nasty catch somewhere, but they are the exceptions and not the general rule.

The salary you may expect will naturally depend on the type of employment and even more on its degree of security. There are plenty of "hire and fire" jobs in the engineering world offering high salaries. But money is not the sole guide as to a job's worth. For my part I consider it worth at least £300 a year to avoid the expense and the life of working in London. As they say up north—"Where's muck there's brass" but not everyone likes the muck.

If you are determined on retiring it is not a bad thing to decide the very minimum salary you can survive on, then take the first reasonable job at this salary without waiting for the plums. Your first job will by nature entail a lot of gaining experience. After a year or so you can in all justice ask for a rise, failing which you are in a better position to seek a higher salaried job elsewhere based on your experience.

Unless you wish to spend all your time abroad, you must get some experience of home conditions as experience abroad is not regarded very favourably at home. If your first few years are spent abroad, when you return home you will be older and probably in a worse position than when you retired.

You must remember that as you get older it will be increasingly more difficult to make a fresh start in occupations. It is important therefore that you start with positions that will provide either some security or else useful practical experience. Generally I noticed when job hunting that the higher salaried posts had some snag. They might be of a temporary nature or unduly risky or even just deadends. You may have to choose between a reasonably salaried lower appointment and a high salaried specialized job where a mere change of policy or a slip on your part may see you out and at a more awkward age and still without that experience so useful in securing jobs.

High posts have an unfortunate habit of suddenly becoming redundant and are more susceptible to changes of policies and the temperaments of managements. An intermediate post may combine reasonable security with useful experience besides providing more congenial employment less susceptible to the harassing tempo of big business.

Remember also that it is very difficult to gauge the exact extent of local inflation and cost of living, so do not be too enthusiastic over large salaries offered overseas. Many companies have the local costs pretty well balanced so as to leave little over unless you are prepared to go to particularly offensive places.

Another matter is that of rank and reference to your service life. It is an unfortunate fact that the popular line to take is that the services are wasteful and inefficient organizations; even though most reasonable people are prepared to admit on the quiet that there is a lot of good in the services. My own view is that it is far better to drop your rank and even in your correspondence in search of work. To many civilians in this age of equality rank implies snobbishness. To others the use of rank implies either a regular officer who will not know much, or else a true civilian putting on airs. Certainly in your new job it is better to be plain "Mr." Everyone will soon find out that you are an ex-regular, so just leave it at that and avoid making any reference to your service life unless asked a direct question.

To make criticism or comparisons between civilian and service ways of doing things is an obvious faux-pas but at times you will find the temptation almost irresistible. Having been trained to look at problems one way it is difficult after half a life to look at them another way. But people who live in glass houses should not throw bricks and there is a lot that can be criticised in the army too. Possibly one is trained in the army to be more critical with numerous inspections, courts of inquiries, etc. It certainly produces an investigatory complex but remember whereas any fool can make a plan, it takes brains to lead a platoon; and the stupider something may appear, the more likelihood a reason for it.

For my part one of the more noticeable differences between the services and industry is that in the services one expects to consult experts and then give orders, whereas in industry those who give the orders are expected to know all the answers as well; anyway in the lower executive ranks. This is quite logical as there is far more specialization and not so much jack of all trades attitude.

You will also notice a sort of instinctive secretiveness of the specialist towards outside inquisitiveness—"too technical for you"; "you would not understand" attitudes. You will also notice that people can be extremely touchy over detail which you yourself would not bother about. All this arises no doubt from the intense competitive struggle in industry to get on and to fend for oneself. There is no regular promotion, no guarantee against dismissal and few people of independent means who can afford an easy going carefree attitude to work in general. Even your salary is a well kept secret so that your neighbour does not know that you have managed to squeeze a rise out of the management, or conversely the management has refused your request for a rise. Empire building is a more developed art and there is a certain lack of readiness to delegate work yet alone responsibilities to juniors.

For the most part your fellow workmates will have had a hard and arduous training. A fortunate few may have had a few carefree years at a university but the majority will have gone straight from school to work starting on a mere pittance during their pupillage or apprenticeship with their evenings fully occupied by evening classes. Compared with their military contemporaries they have had neither the opportunity nor the encouragement to indulge in a medley of interests and occupations. It is not till you leave the services that you can fully appreciate the wonderful opportunities that are still available in the army and how much encouragement is made to widen your interests by travel, generous leaves, special courses, etc., not to mention the wide range of friends and contacts who can even further extend your knowledge and experiences.

This change to civilian life can be treated either as a challenge to be overcome or allowed to develop into a neurosis. For my part I have regarded it as an inevitable challenge throughout my service life; and I would add that in spite of the resulting upheavals, I have not the slightest regrets for having chosen the army for the first half of my life. I can only hope that I have shown the importance of cultivating the right approach towards retirement and also given a few ideas of its difficulties and how to tackle them. But I do not suggest that subalterns should be allowing this problem to bear heavily on them; instead they should concentrate on enjoying life and let these problems wait till they are approaching the status of "middle piece" officer.

Memoirs

GENERAL SIR GUY C. WILLIAMS, KCB, CMG, DSO

(Former Chief Royal Engineer)

GUY CHARLES WILLIAMS was born at Bangalore, India, on 10 September 1881, and educated at Sherborne School and the Royal Military Academy, Woolwich, whence he was commissioned into the Royal Engineers on 2 May 1900.

His early service was spent in Regimental Duty in Bermuda and with 9 Field Company at Colchester. He was later employed on survey under the Colonial Office and was Director of Survey East African Protectorate from 1912 to 1914. He was in Nairobi when war was declared but arrived home to join 54 Field Company at Chatham which became part of 7 Division in Belgium in October 1914. He gained rapid promotion to Brevet Major in 1915 and to Brevet Lieut.-Colonel in 1917. During the First Battle of Ypres he commanded his Field Company for a time. In 1915 he commanded 173 Tunnelling Company at the battle of Aubers Ridge and he was promoted Lieut.-Colonel, Controller of Mines, First Army in 1916. In 1917 he was appointed CRE 66 (East Lancashire) Division and promoted Brigadier-General Commanding 199 Brigade of 66 Division in April 1918.

He was mentioned in Despatches seven times during the war, and awarded the DSO in 1915, the Order of Saint Stanislaus (with swords) in 1917 and the CMG in 1919.

After the war Williams became a student at the Staff College, Camberley, being one of the first batch of selected students to go there when it re-opened. From 1920 to 1922 he served as GSO2 and GSO1 in India and was for a time an Instructor at Quetta, returning home in 1923 to become Deputy Military Secretary, the War Office, until 1926 during which period he was promoted substantive Colonel. In 1927 he returned to India to command 8 Infantry Brigade, Meerut.

From 1928 to 1932 he was the Army Instructor at the Imperial Defence College, after which he became Chief Engineer, Aldershot Command. On his promotion to Major-General in 1934 he was posted back to India to become Commandant, Staff College, Quetta. In 1935 he was awarded the CB.

He returned to England in May 1937 to become GOC 5 Division at Catterick. In January 1938 he was promoted Lieut.-General and shortly afterwards became GOC-in-C Eastern Command. In 1939 he was awarded the KCB. In March 1941 he was promoted General and became the Military Adviser to the New Zealand Government until his retirement in December of that year.

He was made a Colonel Commandant RE in February 1940 and he was Chief Royal Engineer from June 1946 until September 1951.

After retirement from the active list he was employed with the BBC as Overseas Establishment Officer in 1942. In 1944 he was appointed Resettlement Officer charged with replacing BBC staff returning from the Services and other war work. When this task was completed he remained on part-time work with the Corporation until he retired in March 1958. He died 2 February 1959.

He married in 1912 Ruth Eleanor, daughter of the Rev. Athelstan Coode, who died in 1948. He is survived by two sons. M.G.T.

TRIBUTES

C.A.W. writes: To those who were privileged to serve under him and still more to know him intimately, Guy Williams was an inspiring leader and a wonderful friend. As a Sapper Officer he had wide experience: in peace, in fortress and field companies, in survey and as Chief Engineer: and in war, in field and tunnelling companies, as Controller of Mines, as a Divisional CRE and as a Brigade Commander. As a soldier he was one of those rare men who combined to an outstanding degree the qualities of a Commander, with those of a first-class Staff Officer and administrator. He was a keen rider to hounds, a good rugger, tennis and squash rackets player, and he enjoyed golf and fishing.

Williams was quiet and unassuming. He much preferred to sit at the back of a church or at a meeting, whenever he could. He was not a fluent speaker, though I have seen him visibly move a New Zealand audience in an after-luncheon speech by his description of the bombing of London. But he was a great raconteur, absorbingly interesting and witty. More than one Sapper Officer took up Survey after hearing him recount his experiences in East Africa and on Boundary Commissions. He was universally liked throughout his service by his juniors, equals and superiors, and in the concluding years of his service he was regarded as among the first dozen officers at the head of the Army.

Williams bore a charmed life during the 1914–18 War, all of which was spent in France and Belgium. Apart from normal periods of leave and rest, there was hardly a day in which he was not somewhere in the forward area and often in "no man's land". Though, in fact, a man who worried a good deal, he appeared imperturbable under fire or in a crisis, and set an example throughout those long years which won the admiration of all who knew him. Many gratefully remember the effect of his unflinching bearing and quiet reassuring voice. Perhaps his greatest test was in March 1918 when as CRE 66 Division, he was suddenly ordered to take over 199 Infantry Brigade three days before the German offensive against the Fifth Army. He came through that ordeal of battle and retreat with flying colours. Later, his Brigade was reformed with fresh battalions from Salonika and Palestine, and made a name for itself in the break-out from the Hindenburg line, at Le Cateau and Landrecies, and finally, with another Brigade, as advance guard to the Fourth Army in November 1918.

Williams was a quick and indefatigable worker. Perhaps his greatest test in this respect was as Army Instructor at the Imperial Defence College when, for nearly a year, he had to carry the whole burden of instruction owing to illness and changes among his colleagues. It was this exacting year which brought on the nervous twitch in his left eye, which many will remember. He was as tireless in private matters as on official duties. His relatives and friends all turned to him in times of trouble and always found not only sympathy and understanding but a solution to their difficulties.

A man who never forgot his Maker and regularly turned to Him for strength and guidance, a devoted and beloved husband, brother and father, a pillar of strength to all who knew him, one of the outstanding soldiers of his time, equally successful in retirement as a civil administrator, General Sir Guy Williams was indeed a Chief Royal Engineer, who will long be mourned by those who knew him and whose memory will never fade.

General Sir Guy C Williams KCB CMG DSO, Chief Royal Engineer June 1946 September 1951

F.S.G.P. writes:—Apart from *The Times* Obituary Notice on General Sir Guy Williams, and a charming tribute from a former colleague in the BBC (where he worked for some years after his retirement from the Army) there has been no reference in the press to this outstanding officer. Moreover, at his own wish no Memorial Service was held for him. This is typical of the man who, to quote from *The Times* Notice, "to the general public was hardly known" and it is only after some hesitation that I write these few lines, as a contemporary (we received our Commissions within a few months of each other, at the turn of the century), and intimate friend.

Even as a junior subaltern he was often referred to by his seniors as "a grand officer"; indeed it was hard to imagine anyone more thorough, more reliable, and more a master of any job he had in hand. Williams was not only a first-class field engineer, but he was a specialist in Survey, and was one of the first officers selected to develop the "Tunnelling Companies" during the First War. He received the "blue ribbon" of purely Corps appointments, that of Chief Engineer, Aldershot, in 1932. He was also an outstanding staff officer, so much so that he became Commandant of the Quetta Staff College two years later where his earlier experience as Instructor at the Imperial Defence College, was invaluable. His human, as well as military qualities, had previously had full scope as Deputy Military Secretary at the War Office, and later as Military Adviser to the Government of New Zealand. Williams was a fine Commander, too, of a brigade and a division, and eventually became Commander-in-Chief Eastern Command from 1938–1941. Surely a unique career.

He was not only "quiet and unassuming", but his modesty and intense dislike of publicity made even attendance at anniversary dinners and re-unions, quite an ordeal; it was no small feat to secure his attendance at such functions! The remarkable career and outstanding achievements of Guy Williams have been written, perhaps in invisible ink in the records of his time. But as the years pass his name will surely be found on the Roll of Fame of Royal Engineers, engraved in Letters of Gold.

MAJOR-GENERAL CLIFFORD COFFIN, VC, CB, DSO*

Colonel Commandant Royal Engineers (Retd)

On Wednesday 4 February there died at Torquay within a week of his eighty-ninth birthday Major-General Clifford Coffin, VC, CB, DSO and bar, late Colonel Commandant of the Royal Engineers, who in his lifetime carried out to the full the Corps Motto: "Ubique", "Quo fas et gloria ducunt". The younger son of Lieutenant-General Sir Isaac Campbell Coffin, KCSI, a veteran of the Indian Mutiny, and Catherine Eliza, daughter of Major Shepherd, also an officer of the old East Indian Company, Clifford was born at Blackheath on 10 February 1870 and educated at Haileybury.

He was gazetted Second Lieutenant in the Royal Engineers on the 17 February 1888, a week after his eighteenth birthday, and the youngest member of his Batch. His elder brother Campbell, born in 1867, had already joined the Corps in February 1886. Clifford's Batch only completed 18 months at the Shop and were gazetted RE Officers on the same date as the Batch above them, presumably owing to the shortage of RE Officers, the Batches in those days only totalling some dozen or so officers.

Clifford's first spell of foreign service was with the Submarine Miners at Jamaica from December 1891 to March 1894. He was promoted Captain on 17 February 1899 and was at the Staff College, Camberley, that year before leaving for South Africa, where he was employed as Assistant to the CRE of the 6 and 10 Divisions and subsequently as CRE Standerton. He was at the relief of Kimberley, in the Paardeberg operations and the actions at Poplar Grove and Driefontein and in the Transvaal Operations, including the action of Zillikat's Nek. During 1900 he was also present at the battle of Rooidam in Cape Colony. Later on during the war he served in the Transvaal, Orange River Colony and Cape Colony, being mentioned in the dispatches of November 1900, and receiving the Queen's Medal with 4 clasps and the King's Medal with 2 clasps.

Returning to England in July 1904 he was employed in September in the Intelligence Department at the War Office as Staff Captain and subsequently as GSO3. Promoted Major in January 1907 he returned to regimental duty until appointed GSO2 in June 1911 at Sierra Leone where he remained for three years.

Appointed CRE of 21 Division of the New Armies he was present at the Battle of Loos 1915 and of the Somme 1916. He had been promoted Lieutenant-Colonel in June 1915; in the New Year's Honours List 1917 he was awarded the DSO, and in the following March selected to command the 25 Brigade of 8 Division. In September 1917 he was awarded the Victoria Cross "for most conspicuous bravery and devotion to duty". Early in the third Battle of Ypres, when his command was held up in the attack owing to heavy machine-gun and rifle fire and was establishing itself in a shell-hole line, he went forward and inspected his front line posts. Though under the heaviest fire and in full view of the enemy he showed an utter disregard of personal danger. It was largely owing to his personal courage and example that the shell-hole line was held in spite of the very heaviest of fire.

During the German offensive of March 1918 he was conspicuous in the retreat south of the Somme. At one time he commanded all the infantry of his Division. He gained a bar to his DSO in May 1918 and he was given command of 36 (Ulster) Division which he led during the advance to victory in Flanders.

After the Armistice he was given a Brigade in the Rhine Army and in September 1919 posted to command 16 Brigade in Northern Ireland. In June 1920 he was posted to Ceylon to command the troops there, and in July of that year appointed ADC to King George V. He returned to England and retired as a Major-General in November 1924. In 1936 he was made a Colonel Commandant Royal Engineers which appointment he held until 1940. After his retirement he devoted himself to the British Commonwealth Ex-Service League. He was Chairman of the Executive Committee of the League during the 1939/45 war.

Coffin married Helen Douglas, elder daughter of Admiral Sir Thomas Sturges Jackson, KCVO, on 22 August 1894. She died in 1949. Of his four children one son and two daughters survive him, also one grandson and one great grandson; a great granddaughter was born a month after he died.

A Memorial Service was held for him in the Garrison Church, Chatham, on 9 April last which was attended by members of his family and personal friends. The Chief Royal Engineer represented the Corps at the Service. The Institution of Royal Engineers, the Royal Engineers Association and the British Commonwealth Ex-Service League were represented. An old Comrade, who had served under General Coffin many, many years ago, also attended the Service.

C.G.F.

Sir Ernest Harston, CBE, Honorary Secretary of the British Commonwealth Ex-Service League, paid the following tribute to Major-General Coffin in the March issue of the *Empire and Commonwealth*:

"Field Marshal Lord Milne said: 'What more can anyone add to a record such as that of General Coffin?' It certainly speaks for itself. In whatever he did he excelled because he put his whole heart in the job without worrying about himself—on the Staff, in the field and in civil life afterwards it was the same, as the BCEL, the Diocese of Chichester, the Society of St. George and many another worthy cause can abundantly testify. Yet he used to look me sternly in the eye and say that most of the harm in the world was caused by people trying to do good!—something which he never stopped doing.

"His years as Chairman of the executive of the BCEL were very anxious ones—a major reorganization had to be carried out. It was doubtful if it could be successfully done—or even if it were, it was going to be possible to carry on—let alone progress. That we did so was due largely to his quiet inspiration, his amazing loyalty and his wide knowledge of men and affairs.

"To carry out his days at Manchester Square he had to leave at a very early hour from his home after attending to the many tasks he did there. He was amazingly good at reducing page after page of legal briefs and opinions into one sheet of foolscap. 'You forget,' he said, 'I am a trained staff officer!'—with that little twinkle at the back of his eyes that endeared him to all who knew him. He could say less with more effect than anyone I knew.

"No one could be easier to work under and nothing anyone can say will adequately express what, not only the BCEL throughout the Commonwealth, but the Commonwealth itself owes to Clifford Coffin."

Major-General Clifford Coffin VC CB DSO, Colonel Commandant RE

BRIGADIER E. de L. YOUNG

EDWARD DE LORENTZ YOUNG, who died on 28 January, 1959, was born on 10 February 1882, being the eldest son of Colonel A. E. Young, 11 Hussars and Bengal Staff Corps.

He won the Sword of Merit at the RMA Woolwich and was commissioned into the Royal Engineers on 18 August 1900. At the SME Chatham he won the Fowke Medal.

In October 1902 he was posted to India where he spent most of his service and where he became a High Professor in Oriental Languages. From 1902 to 1916 he acted as Garrison Engineer at Peshawar, Dera Ismail Khan (Punjab), Landi Kotal and Karachi.

In January 1916 he was sent to Mesopotamia in command of 11 Labour Corps composed mostly of Punjabi tradesmen for work on the L of C. He became a Brevet Lieut.-Colonel in June 1917 and from April 1918 until February 1919 he was an ADW Mesopotamian Expeditionary Force after which he was made CRE Dunsterforce in charge of building roads and accommodation in the Persian mountains.

From 1920 to 1926 he held appointments at home as District Officer Hereford and as Staff Officer to the Chief Engineer, Southern Command.

April 1926 saw him back again in India where he served until being placed on half pay in December 1932, his appointments included CRE Bombay, Officiating Deputy E-in-C (Works) Simla, CRE Peshawar District, Deputy Chief Engineer and Secretary PWD Peshawar and finally Chief Engineer Northern Command India.

In March 1913 he married Mabel Douglas youngest daughter of the late Colonel J. H. Prendergast, Indian Army and Mrs. Prendergast.

J.H.S.L.

BRIGADIER S. J. ARMSTRONG, OBE, MC

SERELD JOHN ARMSTRONG, who was drowned in the sea that he loved, at Mahé Seychelles on 1 February 1959, will be remembered by a large number of officers, mostly now retired as "Ca-ams". Commissioned in July 1914, after a shortened course at the SME, he joined the 2 Field Squadron in January 1916. He was awarded the MC in 1917 and the OBE in the Birthday Honours List 1919.

After the war he was in one of the first batches to return to the SME for a supplementary course in 1919.

There he stayed till October 1924; for his obvious understanding and liking for cams pointed him out at once for the first post-war Assistant Instructor in Workshops.

During these four years Supplementary courses, JO courses, and later YO batches, drifted through like hordes of caribou.

They drifted in and out of the sight of an instructor but to each individual of those hundreds, the Instructor becomes temporarily a focal point which is remembered. In the case of S.J.A. he became "Ca-ams", the kindly Scot whom some tried to "rag", but without success. It is useless to try to tease one who cannot see the point of it, is not the least ruffled thereby, and cannot think or believe ill of any man, nor feel nor show a sign of malice.

Off duty, his main interest lay on the waters. Anything that could put to sea attracted S.J.A. His exploits as Mate and Skipper, REYC were many and varied.

After an E and M course, 1924–6, he went to India to the humdrum life of the Military Engineering Services.

On the outbreak of war he was CRE Poona. From there he went as Deputy Chief Engineer British Troops Sudan and later a Chief Engineer (Works) PIAFORCE. In 1944 he returned to India holding the appointments of Director of Works and Deputy Chief Engineer Southern Command, until his retirement in July 1948.

On 29 September 1928 he married Mary Lacy, daughter of the late Mr. and Mrs. Just of Nuwara Eliya, Ceylon, at Simla, who died at Kilkenny on 5 June 1958.

A.C.F.

COLONEL E. A. CRANE, MC

Edward Archibald Crane was born on 25 September 1897 and educated at Harrow, and commissioned in the Royal Engineers in July 1915. He served with distinction in France. He was twice wounded and awarded the Military Cross. From 1919 to 1920 he took part in operations in Iraq and on the North West Frontier of India. From 1921 to 1922 he was in residence at King's College, Cambridge, on a course for Royal Engineer officers. Between wars, except for a period in the South Irish Coast Defence from 1931 to 1934, most of his service was in India. Among other things, he was called to Quetta immediately after the great earthquake of 1935, to command one of the special companies formed to render first aid to that stricken city.

During the Second World War his services included a period as Deputy Chief Engineer, Middle East Land Forces. He retired in 1947, when Deputy Chief Engineer, Southern Command at Poona, and settled in Burwash, Sussex.

His hobbies included sailing. He owned Royal Engineers' Yacht Club *Stella* (yawl 20 tons). He also was an enthusiastic gardener and took a very active part in local affairs, He was a valuable member of the Battle Rural District Council, becoming a Councillor in 1956, and also did in his unobtrusive way, considerable work in helping others through the British Legion. Many ex-Service families in Sussex have reason to be grateful for his help.

To sum up the courageous, conscientious, and truly modest character of Ted Crane, one little story serves. Although an indifferent swimmer, when quite a young man he dived off a troopship to assist a sailor who had fallen overboard, for this he was awarded the bronze medal of the Royal Humane Society. His wife did not know about it until, many years later, she came across the medal in his kit.

He married D'Oyly elder daughter of Angus D. Dunbar of Buenos Aires in Chelsea Old Church, on 18 July 1934. She survives him. He died on 1 March 1959.

C.F.M.

Correspondence

38 Corps Engr. Regt.
Deverell Barracks, Ripon, Yorks.
12 April 1959

The Editor, *R.E. Journal.*

Dear Sir,

In the correspondence provoked by Brigadier J. B. Brown's article—"Whither the Corps?", Christmas Island has been widely quoted as the ideal major engineering project for the training of field units. Having recently returned from Christmas Island, all of us in this Regiment will heartily agree. Assuming that we shall have long enough in UK to make up our backlog of training in military and field engineer training, I believe that our year on Christmas Island gave us better training for our likely cold-war tasks than we could have got anywhere else in the world.

The tasks of field engineer units in the current cold war certainly demands more civil engineering and less assault pioneering than most of the previous big and small wars in this century. In Malaya, for example, the major task of field sappers has been the building of roads (with many bridges) to places never served by roads before, not only to enable Security Forces to move freely and protect the scattered population from the terrorists, but also to bring them the benefits of government (schools, medical services, etc.) and a means of getting their surplus produce to market (instead of selling it to the terrorists for lack of any alternative). As in other cold war theatres the work of the army is inextricably mixed up with the business of civil government and the economy of the country. The direct Security dividend from their work, great as it is, may be small compared with economic and psychological dividends. And, of all soldiers, the sappers can probably do the most to win the "hearts and minds" of the people.

But I would not go all the way with Brigadier Brown's article. In Malaya, Cyprus, or any other troubled country, the purely *operational* tasks of the sappers—i.e. infantry fighting, dealing with mines, and producing emergency bridges and ferries—are far more important than their civil engineering tasks, even though they may arise less often. This is because, when such tasks do arise, there is no time to make up training backlogs or to feel one's way, and the penalties of failure are likely to have a far greater effect on the political and operational issues than any inefficiencies in carrying out civil engineering tasks. For example, Major Coombe's squadron went to Cyprus to build camps, but within a few weeks they had been involved in a bridge demolition, a buried mine charge and three ambushes all involving fatal casualties. After reading Major Coombe's excellent article—"Winter in Cyprus" in the March *Journal*, can anyone doubt that these occasions and their outcome had more influence on the war than all the hutting put together? Or that they were putting first things first when they were found trying to teach Sapper Dormouse to hit the target when their five days notice came on them out of the blue?

"Its all a matter of priorities". A fine old military cliche, but it is. Let us put, "the next war" where it belongs—last. Let us instead concentrate on the current war. Our training priorities for field units in non-operational theatres (i.e. UK and BAOR) should be:—

I. Military and field engineer training for tasks likely in the cold war.
II. Civil engineering projects of a type similar to likely cold war engineering tasks.
III. Training for the hypothetical "hot" war.

The practical effect of this would be, for example, that the laying and breaching of huge minefields would go to the bottom of the list. Not far above it would be engineer tasks in manoeuvres involving brigades and higher formations. At the top would be the training of small parties in combating snipers and guerillas, and the detection and disposal of improvised mines and booby-traps. By ruthlessly pruning hot-war training, it should be possible for field units to find time for civil engineering projects in between their periods of training for cold war operational tasks.

I agree with Lieut.-Colonel Jackson's comments, however, that the maintenance of barracks in non-operational theatres no longer provides suitable training for military engineers. I, for one, am glad to see the Works Services dwindle. Acting as accountant and agent between the user, the architect and the contractor is not really a soldier's task, and is one on which too many good officers have frittered away too many valuable years. Nor do I think that field units would generally gain much benefit from such tasks. However hard we try to confine their work to new construction they would inevitably become involved in modifications and maintenance, and these do not provide good training for officers or tradesmen; it is easy to find excuses for shoddy work, and there is little scope in such tasks for fostering professional pride.

One of the great joys on Christmas Island was that the officer was responsible from start to finish and there was no escape from that responsibility. It is true that the squadron or troop leader was given a design (by another sapper officer) but he was also given ample scope to change the design (subject to approval) to suit the wishes of the user. He then had to build it *with his own men*. If it was late, or if it leaked or collapsed, there was no contractor to be blamed. There was no alibi at all. And that is the sort of civil engineering we want—not just the circulation of agents or observers.

The ideal for training, of course, would be for field units to divide their time between operational theatres and projects such as Christmas Island—which should be eagerly sought all over the Commonwealth. Inevitably, however, some field units have to be stationed in non-operational theatres—i.e. BAOR and the UK. Having covered their essential military and field engineer training (and even in BAOR—so long as the risk of a major war is no greater than at present—this training should have strong cold-war bias) time must be found for civil engineer training. But, if we rule out works services in barracks what civil engineer training can they get?

The answer lies, surely, in our undertaking major civil engineering projects for government or local authorities, both in UK and on the continent. Many of your correspondents have advocated this. Sadly, however, there appear to be formidable objections, certainly in the UK. In time of unemployment, such objections could be understood if army engineers were going to deprive local contractors and workers of their living. But for work on the roads, these objections are seldom valid, for the volume of work required is almost unlimited. There are innumerable narrow bridges and dangerous bends which have no hope of getting money allotted to their improvement within the next few years, and which will remain "black spots" unless the army is allowed to tackle a few of them. Such tasks would offer splendid training to field troops supported by plant, and I believe that we should fight ruthlessly against the objections which are raised against our doing them. The best approach would seem to be to have the arguments publicly discussed. A field squadron with supporting plant costs the taxpayer more than £3,000 a week, whether it is doing anything useful or not. If Parliament were told this fact, and told at the same time that such a force is available now to deal with certain "black spots" which will otherwise go on taking their toll of accidents for years, and that dealing with these black spots will give the best possible training value for their £3,000—it is hard to believe that the objections would not be swept aside.

I am convinced that there are many other big civil engineering projects—both in UK and on the continent—whose completion would give great benefit and satisfaction to the public, but which cannot be done unless the army does them for nothing. We should not be mean about the cost, because all training costs money, and this would be the training that we need most.

To sum up, I agree that we need more civil engineer training, but I suggest that:—

(*a*) Military and field engineer training for *cold-war* tasks must continue to take highest priority for field units.

(*b*) Training for field engineer tasks which are likely only in major wars should be sacrificed in favour of increased civil engineer training.

(*c*) The finest civil engineer training obtainable is in projects such as that on Christmas Island. Such projects should be sought, whether for military or civil purposes, all over the Commonwealth, and considerable risks accepted in diverting field units from non-operational theatres—UK and BAOR—to do them.

(*d*) Barrack construction and maintenance does not offer satisfactory training for field units. Where it is essential to hold field units in non-operational theatres, every effort should be made to deploy them on major civil engineering projects—such as road or bridge construction for government and local authorities.

R. L. Clutterbuck, Lieut.-Colonel, R.E.

H.Q. Allied Forces Northern Europe,
Oslo,
Norway.
31st April, 1958.

To the Editor
Royal Engineers Journal

Dear Sir,

The article and letters on "whither the corps" make interesting reading indeed.

I would like to add a few points:

(*a*) Although it is obviously healthy and necessary for the Corps to discuss its own future it seems to me that it is now necessary for the Army Council to redefine the aim of the Corps. The Corps must be told what is expected of it by the Army in a nuclear age. Let the aim be defined and the Corps will get on with the job.

(*b*) Having said that my own views are that it is dangerous for too much emphasis to be placed on civil engineering and particularly theoretical civil engineering.

I believe that the Army will require in a nuclear war, field engineering above all things. The practical common sense, even "Heath Robinson" engineer. The main job will be to keep the communications open. This will have to be done with any material or equipment that may have survived the initial atomic attack. Improvisation will be the essence and practical "do-it-yourself-manship" qualification.

I have discussed this with officers of other arms and corps; all are of the opinion that what they require of the Royal Engineers is practical field engineering.

A second and important role will be the rehabilitation for which the Territorial Army should be trained. The specialists that will be required during this phase should be in the Army Emergency Reserve.

(*c*) Often those who argue for improved civil engineering qualifications have in mind the improved opportunities this gives for subsequent civil employment. I would suggest that this is quite irrelevant. One does not, or should not, join the Corps because it gives one qualifications for civil life, but because one wants to join the Army, and the Corps offers a life probably more interesting and varied than any other arm or Corps.

(*d*) Finally, other rank recruiting. I suggest that the time has come for a radical review of our trade requirements in the Corps. We should no longer try to compete with such Corps as R.E.M.E. by suggesting that we can offer a recruit full- or even part-time training at his trade. It is very rarely possible and ought to be considered as a bonus.

I believe then we should stop over-emphasizing the trade training possibilities and lay more stress on the warlike, martial qualities required. Let us go for keen young men who want to be "first in and last out of battle" which will certainly be required of them in a nuclear war.

To sum up the qualities required of a Sapper, in nuclear war, are, I suggest:—

Common sense, a practical, basic engineer background, "do-it-yourself-manship", above average intelligence, enthusiasm, guts and determination.

Yours faithfully,

D. R. Freeman, Major, R.E.

Book Reviews

KITCHENER—PORTRAIT OF AN IMPERIALIST

By PHILIP MAGNUS

(John Murray, Albemarle Street, W1. Price 30s.)

By long established custom, the editor of the *RE Journal* does not order the review of a book unless the Corps Library at Chatham has received a presentation copy of it from the publisher. Philip Magnus' *Kitchener*, alas did not come as a gift from Albemarle Street and had to be bought in the ordinary way. Despite this, a review is still to be made, since it would ill become the Corps to neglect to notice a fine book about one of its most illustrious sons.

Some great men seem to be "strange uncomfortable works of God", out of harmony with their contemporaries. Gordon was such a one and Kitchener was another. Both were Sappers, who got to be known in curiously similar ways, off the ordinary beat of professional soldiering. Both had a passion for glamour, romance and fame, which knew no bounds. Later on, the deserts of the Sudan brought military renown to Kitchener and a martyr's glory to Gordon. There, in those sandy wastes, the two men came to recognize one another as kindred spirits struggling with a colossal military and political muddle. Gordon went so far as to tell Kitchener that he would be well suited to take his place as Governor-General—when Gordon was killed, Kitchener, for his part, determined to be his avenger. He foresaw well enough, that the British public would acclaim Gordon's avenger as a veritable master of war. Apart from brief periods, the next thirteen years saw Kitchener devoting himself almost entirely to becoming the dominant military personality in the Nile Valley. Spurred on by ambition and mindful that a soldier who aims at the highest commands must know the highest people in the State, he made firm friends with some of the best known men and women in Britain. These included members of the Salisbury family with whom he stayed at Hatfield and elsewhere. For many years he was also an intimate correspondent of Lady Salisbury, the wife of the great Prime Minister.

Many rivals had to be circumvented, vast factors of time and space had to be brought under control and several preliminary battles had to be won, before the now tremendous Kitchener was able to appear on the stony plain of Kerreri in supreme command of the Anglo-Egyptian Army, which destroyed Mahdism in a few hours. The avenger of Gordon was indeed accepted as a master of war, not only by the British people but by the whole civilized world as well. Thereafter the great man moved on as he wished to high posts in South Africa, India and Egypt. Yet in 1914 his forlorn attempt to steal back unnoticed to Cairo revealed Kitchener's dread of becoming entangled in the British conduct of World War I. He had not spent a winter in England since 1878, he knew nothing of the War Office and he hated democracy—a great soldier but in Britain an anachronism. In the end Providence mercifully stepped in to save his proud spirit from the final humiliation of a failure, which was already gnawing at his heart.

Philip Magnus' splendid book gives chapter and verse of a truly meteoric career and provides the full dress biography, which Lord Kitchener so well deserves. The long fascinating narrative unfolds easily and without partisan discordances from the start to the end of its 381 pages. The final judgements are fair and impartial without any modern style disparagement of a man, who, whether in success or failure, was always great. The well chosen illustrations reveal something of the splendour of Kitchener's personal appearance, which helped him so much in his early years. The two Partridge cartoons from *Punch* remind us how quickly the Kitchener legend has dated. Osbert Lancaster's caricature on the dust cover, however, is mercilessly up to date and perhaps not in the best of taste.

Kitchener has many memorials, but perhaps the best of them all is at the junction of the Blue and White Niles, where he rebuilt the town of Khartoum. Even today, so travellers declare, the splendid Palace and the large official houses along the river bank, each surrounded by a high brick wall, have an elegance, now faded, which Kitchener himself inspired. B.T.W.

THE TWENTIETH MAINE

By John J. Pullen

(Published by Eyre and Spottiswoode. Price 30s.)

The Author has tackled a difficult task with some distinction in *The Twentieth Maine*. The book tells the story of a regiment during the American Civil War. The Twentieth Maine was formed in 1862 in Portland, Maine, under the command of a young Colonel only fourteen months out of West Point. For Second-in-Command the Colonel had a Lieut.-Colonel, Joshua L. Chamberlain, who was destined to win fame in American Army annals. The young Colonel was shocked at what he had been called to command; and it is difficult to say which seemed the more unpromising, his regiment or his Second-in-Command. Instead of saluting, a man would say "How d'ye do, Colonel", without so much as taking his hands from his pockets, or altering his slouching attitude leaning against a tree or other inanimate object. The Second-in-Command had received no formal military training. After graduating from Bowdoin College he had become, successively, a theological student, a teacher of languages to classes of young ladies, the leader of a church choir and a Supervisor of Schools. Aged 33, he was a member of the Faculty of his old college, when he took two years' leave, ostensibly to visit Europe, but in fact to join the Union Army of the North. The Governor was anxious to give him command of a regiment, but he preferred "to start a little lower and learn the business first"; so he began as a Lieut.-Colonel.

The book tells how this strange assortment of men, without uniforms, discipline or arms, was licked into shape; and how it marched and fought continuously from Antietam to the final Confederate surrender at Appomattox. Through it, like a thread, runs the story of Chamberlain's natural aptitude for military affairs. Besides being a first-class man of action he had a scholarly command of English prose, passages of which have fortunately survived to tell the tale of many routine activities, with vivid flashes of description of battle scenes. Some of these would be hard to beat anywhere in the language. The Author has wisely made full use of them; and, by dint of considerable research, has supplemented his story with some excellent contemporary accounts of events. There is an authentic ring in nearly every page of the book. Perhaps its author was also a fighting man.

Besides dealing skilfully with the doings of a single regiment, the Author contrives to give a general picture of the course of the American Civil War. There is no formal exposition of it; it emerges naturally as a by-product of the story. The book is easily read and would be a palatable introduction to a study of this most bloody of wars, whatever the calibre of the reader.

The book also gives some insight into the American character; and the British reader will at once see how many of his own cherished military beliefs are shared by soldiers of the New World. There appears to be, however, a certain freedom from inhibition about the soldiery of the Twentieth Maine that one would not have found in any British regiment of that time. Though our own men might think much the same as their American counterparts, one wonders if they would ever act as spontaneously. There is something attractive about their unsophisticated genuineness.

The book is illustrated by maps and photographs; but the British reader, not particularly familiar with the geography of the U.S.A., would welcome at least one map which related the scene of the war to the whole continent of North America. There are also eight line drawings by Edwin Forbes, artist reporter of the Army of the Potomac, which convey "atmosphere" even better than the contemporary photographs.

Your reviewer, not being addicted to praise of American authorship, cannot forbear to applaud this work by Mr. Pullen. M.C.A.H.

THE FAILURE OF ATOMIC STRATEGY

By Colonel F. O. Miksche

(Published by Messrs. Faber & Faber, 1959. Price 25s.)

The study of abstract theories of war has never been a popular pastime in the British Army, and some may find Colonel Miksche's book difficult to read in spite of its logical arrangement. However, wars are won by those who perceive most clearly the realities behind the ever-changing military factors, and as there never was a time when the course of future war was so hard to determine as it is now, this forward-looking book is of much interest.

Critics of the present military policy of the West fall into two main categories; there are those of the space-ship school who consider current policy hopelessly pedestrian, and there are those of the conventional war school who feel that to contemplate the use of nuclear weapons is unrealistic. Colonel Miksche is a prophet of the latter school.

Colonel Miksche writes as a European and it is from this viewpoint that he reviews the grand strategy of the West. He sees the chief struggle between East and West being for the resources and loyalties of the uncommitted nations, particularly those in the Middle East and Africa. In this struggle, now that there is nuclear parity, the huge forces of the USSR largely equipped with conventional weapons, play a powerful role although they are never used. Moreover they have forced the West into a pre-occupation with withstanding a mass onslaught in Europe for which the Russians have in fact little inclination. The Soviet aim is the much more devious one of conquest of the Middle East and Africa by revolutionary means. From this basis, which many will accept, he argues that given a good nuclear deterrent the main need of the West is for large conventional forces. For it has been abundantly proved that such forces are the only possible way of dealing successfully with revolutionary wars.

He rejects the possibility of a war with nuclear weapons in Europe on the grounds that neither side will choose mutual suicide. Should such a holocaust occur, large conventional armies backed by the deterrent would be more useful than very small ones composed of technicians equipped with nuclear weapons. The West is already spending more on its armaments than the East. Hence Colonel Miksche argues that the Western nations could easily afford to maintain much larger armies if their equipment were more integrated and not so unnecessarily lavish. Moreover, if his suggested new organization were adopted, the proportion of teeth to tail would be greatly improved. The economic and organizational arguments put forward are interesting and plausible, but some readers may find them not entirely convincing.

This is a well-informed and thoughtful book. At first sight many of the views expressed appear conservative, and the comments on some of the contradictions of Western military policy, though sound, are unoriginal. But the argument gathers momentum until it reaches the point where many readers will begin to doubt the wisdom of current British policy. It is very easy for those eager to avoid the trap of planning the next war on the lines of the last, to make the equally fatal error of planning the next war on the lines of the next-but-one. Such ardent spirits, and indeed all keen students of future war, would do well not to miss this well-reasoned book.

If Colonel Miksche is right, and he has often been right in the past, the military policy of the West, and of Britain in particular, is already well off course.

I.H.L.G.

THE NINE DAYS OF DUNKIRK

By David Divine

(Published by Faber & Faber, 24 Russell Square, London. Price 21s.)

For military readers Mr. Divine has spoilt a workmanlike study of the period in 1940 which covers the whole episode of "Dunkirk" by a partisan attitude to a controversy of which there is no end. The controversy hinges upon whether Lord Gort or

Lord Alanbrook played the greater part in the management of the ground battle between 10 May and 1 June 1940.

There was a similar controversy between the wars concerning the Battle of the Marne. Credit for the turn of the tide in 1914 was variously given to Gallieni, to Maunauri, to the French Government, to Sir John French and to others. Very few gave Joffre, the C. in C., any credit, yet that shrewd old French sapper, when asked after the event who won the battle, is reported to have answered dryly: "I don't know who won the Battle of the Marne, but I know who would have been blamed if we had lost it." The same might have been said by Lord Gort after Dunkirk, but he was too selfless an officer to trouble to say it; and there seems little need to go to such lengths as Mr. Divine does to establish the British C. in C's. place in the story of those calamitous days.

Having said that, your reviewer unreservedly commends this book for its scope, for its understanding of military problems, and for the clear and comprehensive way in which the tale is told. Sea, land, and air are all covered.

Recalling a personal note of those days, I remember joining the Intelligence Officer (IORE) as he examined a map of France and drew upon it the great, encircling arms of panzer forces about us. "The Bosche seem to have done very well," someone remarked. "Yes," replied the IORE, "they have done well; and it's funny how we always called them stupid." At the time it did seem odd; yet reading Mr. Divine's book we see now how foolishly they played their cards; how wrongly they evaluated their own position, how timidly they proceeded, and how they lacked faith in their own methods of *blitzkrieg*. It makes strange reading when recalling the almost magical efficiency with which they were credited at the time. The fact emerges, however, that while their tactics were admirable, their strategy was puerile; and there was a hesitancy about it in the higher councils most unbecoming of a "master race".

The German admirals and generals writing today, blame all things upon Hitler. Mr. Divine shows that they too were not infallible. He shows, for instance, what an alarming impression the British counter-attack at Arras made upon the German High Command on 21 May. He quotes Rundstedt as saying that it caused a critical emergency and raised fears that the panzer spearhead might be severed at the shaft before the infantry division could come up in support. There is little doubt that this comparatively small operation had a psychological impact upon the German generals (Rommel and Rundstedt principally) that far outweighed its actual size and scope. It was one of the few well laid-on counter strokes in a campaign of confusion; and those who emerged from Dunkirk have reason to be grateful to those who directed it. Your reviewer believes—though the book does not mention it—that a Sapper (Martel) commanding 50 Division, played an important part in this.

There are some useful maps and many admirable first-hand accounts from the logs of ships that took part in the evacuation—mainly understatements in the most modest vein—and the naval and air sides of the campaign are fully described. Those wishing to get a comprehensive view of this campaign could not do better than take this book from the library and study it.

M.C.A.H.

THE TANKS

The History of the Royal Tank Regiment

By Captain B. H. Liddell Hart

(Published by Messrs. Cassell & Co. Ltd., London. 2 Vols. Price 70s.)

Captain Liddell Hart laboured at this history for nearly thirteen years. In the Preface he says feelingly "I have spent a far longer time on this book than on any previous one and am still far from content." This confession is a measure of the immense difficulty of the task, which he had undertaken. For the tanks were born to trouble as the sparks fly upwards. They were shaped in secrecy and after their creation roused controversies so bitterly inconclusive that it fell to Germany to show Britain how best to use her own invention. The author of *The Tanks* had to explain this puzzling occurrence and to write at the same time a worthy history of the ordeals suffered in thirty years of war and peace by the great-hearted officers and men of the R.T.C.

The fact that the BEF of 1939 went to France without an Armd Div and that it was still without one in May 1940, when the Germans launched their *blitzkrieg*, certainly seems to be an indictment of the British High Command of the inter-war period. Perhaps a gifted Secretary of State could have reconciled the conflicting interests of existing regiments and corps to put armour into its proper place more quickly. Alas, no Cardwell or Haldane, determined to reorganize the Army, took office during those fateful years. So the empire of the horse continued much too long. The cavalry, absolute to maintain their high standing in the Army, gradually compounded with the upstart tanks. They only just had time, before the Second War broke, to exchange their chargers for armour and to continue their existence as part of the Royal Armoured Corps. This solution of the problem was probably sound, since many of the champions of the tanks firmly believed "in the absorption of armoured forces into the rest of the Army". But the decision to make the change was taken at least five years too late. Thus the BEF lacked a sufficiency of armour and had not conceived clear cut ideas on how to use even the tank brigades which it had. The long quarrel about armour reveals very well how, as warfare changes, the various arms wax or wane in their relative importance. Only the infantry continues effortlessly supreme, confident that war will ever be impossible without it.

The history breaks fresh ground in several places. Of the genesis of AFV during the First War, authoritative chapter and verse give a new account of their stages of development and of their many well-known protagonists. The story of the controversies between the wars about the design and doctrine aspects of tanks will also be new to most readers and is perhaps the most interesting part of the history. *Vis a vis* doctrine, however, even Captain Liddell Hart did not quite forecast the novel operational form, which the Germans devised to get optimum results from their *panzers*. This was the pencil-like thrust to a distant objective with the sides of the pencil held by fast divisions. In Vol II the British counter attack at Arras with two Tank Bdes is as fully treated as it can be and the little known operations of 1 Armd Div in May–June 1940 west of the Somme are also described in detail.

Unmindful of the example of Pope in his translation of the *Iliad*, the learned author has made no attempt to weld into a single homogeneous narrative all the contributions of those who have assisted him. Thus the history is somewhat patchy. But it rings true and the reader will find that he seems to share the frustrations, tribulations and perils, which the pioneers of the tanks had to endure for so long.

B.T.W.

THE WELDING HANDBOOK

Fourth Edition—Part II

(Published by Cleaves Hume Press Ltd. Price 72s.)

This edition covers the most modern and up-to-date methods of welding. Each method gives in detail the fundamentals of processes, the equipment required, materials, applications and safety measures to be observed. The illustrations, page numbering, and tables are clear and easy to follow. With the various aluminium and magnesium alloys now being used in service bridging equipments the section dealing with inert-gas-metal-arc welding will be found particularly useful, as it gives details of equipment, techniques and uses. The section dealing with resistance welding leads to a fuller understanding of steel manufactured vehicle body work and the jointing of pipes in refrigeration work.

This book is a useful one to have in a technical library for the use of students, persons concerned in general engineering, and to Officers and Clerks of Works in charge of workshops.

K.F.T.

DESIGN OF PRISMATIC STRUCTURES

By A. J. Ashdown

(Published by Concrete Publications Ltd. Price 8s.)

The structures referred to are those consisting of flat concrete slabs meeting at an angle at their longitudinal junctions. Examples are pitched—slab roofs and trough-bunkers. While the transverse stresses are fairly simply determined, the longitudinal stresses are less easily evaluated.

In the method of analysis described, the longitudinal stresses are expressed in terms of the longitudinal forces at the junctions of the slabs and equations are developed connecting these forces. These equations, which are similar in form to the Three Moment equations for continuous beams, are easily solved by a simple and rapidly convergent relaxation method which is fully demonstrated.

In the original edition of 1951 the author, having developed the theory by reference to a single span structure, went on to consider the design of multi-bay and multi-span structures and structures with sloping ends.

In the new edition, besides revising the existing material, he has included a new chapter dealing with the problems arising when the slabs are inclined to each other at a small angle. In this case the equations are not suitable for solution by the relaxation method and a matrix method suitable for use with a calculating machine is demonstrated.

Great care has been taken throughout the book to deal with the practical aspects of design, and to demonstrate fully the analytical and mathematical methods used. The book is a good exposition of its subject although the type of structure concerned is unlikely to concern military engineers very often. C.R.S.

PLANE AND GEODETIC SURVEYING. VOL. ONE.—PLANE SURVEYING

By The Late David Clark, MA, BSc, MInstCE, MInstCEI, MAmSocCE

Fifth edition revised by James Clendinning, OBE, BSc.

(Published by Constable & Co. Ltd. Price 32s. 6d.)

Clark's *Plane Surveying* is one of the standard text books on the subject. In the fifth edition it has been revised and brought up to date.

Descriptions of the more out of date models of surveying instruments have been omitted. In the text itself there are no major alterations, but the new Appendix I (27 pages) deals with modern instruments.

The chapter on "Setting Out Works" has been expanded and Appendix IV has been completely re-written. This chapter and appendix deals with transitional curves in detail, both the Euler Spiral and Lemniscate being fully explained. Two new tables are also appended to Appendix IV. Table I gives factors for the layout of the Euler Spiral Transitional Curve and Table II gives the factor for determining length of arc of the Lemniscate. W.C.

Technical Notes

Notes from *Civil Engineering and Public Books Review*, February, 1959.

DESIGN AND CONSTRUCTION OF VERTICAL DRAINS TO ACCELERATE THE CONSOLIDATION OF SOILS

For Part 1 of this article (page 197) Vertical drains are described and some applications of their uses are given. There is also a comprehensive table of Existing Installations of Vertical Drains with references to papers on them.

In the complete article the author proposes to describe a method used to design vertical drains to accelerate settlement, the theoretical influence of spacing and diameter of drains, thickness of compressible soil layer, values of horizontal and vertical coefficients of consolidation, and the temporary application of an additional load or surcharge.

REINFORCED CONCRETE T BEAMS

On page 185 under "Letters to the Editor" a graph shows load distribution coefficients for middle and outer girders of five girder bridges with zero and infinite torsioned stiffness. This graph may be of interest to anyone involved in the design of reinforced concrete T Beam bridges.

Notes from *Civil Engineering and Public Works Review*, January, 1959.

THE CONSTRUCTION OF DAMS BY BLASTING

Interesting examples of constructing dams in Russia using high explosives are given on page 59. In one example, necessitated by the imminent flooding of a highly cultivated area, a dam, 45 ft. high and volume 21,000 cu. yds., was made by one blast using 50 tons of explosives. Sketches of sites chosen and position of the charges are given.

THE ANALYSIS OF CYLINDRICAL TANK WALLS

The first part of an article on the approximate method of determining the elastic behaviour of cylindrical tank walls by straightforward calculations, whereby the more complex mathematics required in the vigorous solution is dispensed with, appears on page 68.

The author claims very good approximations are possible for tanks with comparatively small shape factors and that the method is particularly useful in dealing with partially full tanks and tanks with non-uniform walls.

The amount of calculation is reduced and solutions are obtained more quickly using this method in conjunction with a chart of correction factors. Examples will be given in the next part of the article.

THE RENEWAL OF DUDLEY POST AQUEDUCT

Details of the replacement of a wrought iron aqueduct by a prestressed concrete one on a very restricted site are given on page 75. It is interesting to note that the new structure was built on trestles alongside the one to be removed and jacked into place rolling on 3-in. diameter steel balls rolling in the webs of standard bull head rails. The distance moved was 36 ft. 3 in., with two T35 "Tirfor" jacks pulling, and two T13 "Tirfor jacks" restraining.

CONCRETE WITH AND WITHOUT ENTRAINED AIR

On page 77 is described, with graphs and comprehension tables, a series of comprehensive tests on concrete samples with and without entrained air.

The air entrained specimens showed less tendency than the plain concrete to increase in weight during water curing, to decrease in weight during air curing, and to decrease in compressive and flexural strength when cured in air instead of water.

It is noted, however, that the compressive and flexural strengths of the air entrained concrete are less than those of similar plain concrete, but where the specimens were air dried the differences were not great.

CONTINUOUS BEAMS AND ELASTIC SUPPORTS

The final part of this article by B. N. Thadani appears on page 85. In the examples worked out by this method the results show little difference from those obtained by the vigorous method but the calculations are easier. The one limitation pointed out by the author is that the supports must not be too elastic.

HARD ROCK TUNNELLING METHODS

In Part 4 of this article there are some interesting notes on methods of removing rock from the tunnel face. It describes and illustrates track lay-outs and devices to avoid shunting.

Ventilation is also described and a useful table is included giving carbon monoxide concentrations and their effects.

Notes from *The Contract Journal*, 8 January 1959.

An article in this issue deals with the Shockless Use of Explosives for Sandstone Excavation which should be of interest to those likely to be employed on quarrying. It deals with the Swedish "Riktad" or "controlled" method of blasting, which, by spreading the charge as evenly as possible behind the face and using instantaneous detonation cuts off cleanly a slice of rock while imparting a negligible shock to surrounding rock.

Notes from *Civil Engineering and Public Works Review*, March, 1959.

A NOVEL METHOD OF PIPE CLEANING

A report on a novel method of sewer cleaning developed in recent years in U.S.A. is given on page 309. A hollow neoprene ball, provided with diagonal ribs along the periphery, is used. To clear water mains or sewers, the ball is tied to a rope and inflated to fit snugly inside the pipe. The ball is inserted at a manhole and a tension of 15–20 lb. is maintained on the rope as the ball is carried downstream. Since the ball obstructs the main or sewer, water builds up behind it. When this head of water exceeds the air pressure in the ball a jet of water is released past the ball sweeping sediment away ahead of it. At the same time, the ribs on the surface scrape slime from the pipe walls. It is reported that this system has decreased stoppages, reduced the generation of hydrogen sulphide with its resultant sewer and structure deterioration and odour offences and there has been a noticeable decrease in sand wear on parts of the pumps in pump stations.

ENGINEERING DEVELOPMENTS IN THE USSR

On page 311 a method of inducing stress in the reinforcing steel by electric heating is described. It appears that this method is widely used in mass producing floor panels and beams. It is applicable to deformed bars which are pre-heated before they are placed in the formwork. A preference is stated for steel rods rather than wire reinforcement because of the large diameter of the former and the tendency of the latter to corrode. Steel used for electrical stressing can be tensioned up to between 71,000 and 78,000 lb./in.^{2} The reinforcing steel is shorter than the distance between the anchors. The anchors are positioned by means of a jig. The reinforcing steel is heated to between 570° and 750°F (300° and 400°C), the location of the electric contacts ensuring that the ends are not too hot. The tensioning occurs gradually as the reinforcement cools.

Panels made to date vary from 2½ to 6½ ft. in width and 19¼ to 20¾ ft. in length. Time required to heat the reinforcing for one panel is about 2½–3 min. and it takes about 10–20 sec. to place the heated steel in position. Control measurements are given and from the graphs it is seen that the required accuracy of prestress is obtained.

The cost of the electric stressing plant is 5,000 roubles against 50,000 roubles for a plant using conventional jacking and it is claimed that the electric plant has doubled the output; i.e. the electric stressing plant has twice the output at one-tenth of the cost.

W.C.

The External Vibration of Concrete

This paper reviews the principles of compaction of concrete by vibration discussing the influence of acceleration, amplitude and frequency.

Compaction falls into three distinct stages. At the start the concrete mix is a mass of separate particles surrounded by mortar, held in this condition by the arching action of the larger particles and prevented from falling to a lower level by static friction or adhesion. The "initial settlement" shakes the particles together and the end of this stage is marked by a considerable settlement and the closure of the surface. By this stage the concrete resembles a heavy viscous fluid. The second stage is called "de-aeration". The coarse aggregate redistributes itself evenly throughout the continuous matrix of mortar, with the expulsion of air bubbles. The vibration transmitted through the mortar paste breaks down its shear resistance and so assists in the redistribution of the aggregate and the passage of the air. At the end of this stage the surface glistens, and the major eruption of air ceases. The third stage, "stabilization", consists of a general interlocking. Should this process be prolonged, the particles will tend to segregate, and therefore the problem lies in assessing what vibration best assists the three stages up to the optimum density—and how to measure the critical moment when this has been achieved.

The author describes the process in terms of a general mathematical equation in which the degree of compaction at any moment can be derived from the initial compaction, the theoretical maximum compaction possible, and a function consisting of three inter-related variables—(*a*) time (*b*) acceleration and (*c*) workability. In his opinion these three are so connected that it is *NOT* essential to insist on low workability combined with high acceleration: the same result can be achieved by the correct amount of vibration at a more reasonable value for both workability and acceleration.

An important factor is that the rate of compaction increases as an exponential function of acceleration and therefore for low accelerations (less than 1.5g) the time required is impractically long. A further point is that the vibration must be effectively transmitted through the body of the concrete. An amplitude less than 0.0015 in. ceases to have any effect at all—while any effective amplitude also varies in its results with different designs of mix. This effect may be due to different values of cohesiveness. A third factor is the frequency of the vibration. It appears from experiments that there is a critical value of 6.000 v.p.m. Below this frequency the acceleration must exceed 1.5g, while above this frequency the amplitude must exceed 0.0015 in.

The aims of good compaction are (*a*) increased strength durability and uniformity and (*b*) aesthetic qualities of a surface free from blowholes. While it is possible to achieve (*b*) alone by designing the mix alone, to obtain (*a*) and (*b*) together, a not unusual combination since durability may be affected by blowholes, correct vibration is required.

Tests are described in which blocks of concrete were vibrated under strict control, varying the conditions. Results showed that the subsidence (Stage I) of all concretes was faster with low frequency (3.000 v.p.m.) vibration. The surface of all blocks vibrated at high frequencies (9.000 v.p.m.) was superior—except for specially designed mixes of high workability for which varying the frequency had little noticeable effect. The conclusion reached is that an ideal vibrator would tackle Stage I (subsidence) at low frequency and finish off the process at high frequency.

Advice for good vibration is as under:—

(*a*) Make moulds as rigid and as light as possible. Metal moulds (yet thick enough not to "flutter") are best, or timber moulds suitably braced.

(*b*) Apply the vibrator by a rigid clamp, strong enough to resist the centrifugal forces set up in the vibration.

(*c*) Vibrate across the short axis of a long mould, and arrange for several positions. If several vibrators are used at once, set them in different planes and ensure that they vibrate at the same frequency (otherwise their beats cancel each other out).

(*d*) Too powerful a vibrator will hold the particles near its application apart and thus entrap bubbles of air.

(*e*) Rubber mats or mountings should be used under the mould to allow the lowest levels to move freely under vibration.

Of the commercial types available, the commonest is the rotating eccentric type driven by an induction motor at frequencies 3.000, 6.000 and 9.000 v.p.m. Pneumatic type turbo motors can also achieve high frequencies. Electro magnetic types or Pneumatic reciprocating types are rarely used externally. The following Rules of Thumb are listed—(Nos. 1 and 2 being preferred to No. 3).

(1) If all up weight of mould + concrete = W lb.
Centrifugal Force = F lb. wt.
Then $3W = 2F$

(2) If the eccentric moment = M lb./in.
Then $W \times 0.0015 = M$

(3) If the power rating of the electric vibrator = Watts
Then $2W = 3p$

T.W.T.

The Design of Shells

Part I of an article on the design of shells by the application of column analogy states that this method is "particularly appealing to the wide range of engineers not sufficiently conversant with the mathematics of the differential equation"!

The article contains various tables and graphs, and using the method described, the answer has an error of 3 per cent which may be considered to be within normal slide rule tolerance.

The article is to be continued in the next issue.

Application to Fixed-End Struts of The Perry-Robertson Formula

The Perry-Robertson Formula is the basis for calculating the stresses in struts given in BS449. New calculations are given and a table shows the calculated and BSS values for working stress. The BBS values for working stress where $l/k > 80$ are all less than the calculated values, i.e. on the safe side.

Pumping Concrete on a Construction Site

This article discusses the factors to be considered in deciding to use, position and erect a concrete pump on a construction site. It also deals with the problems of pipelines, fixing, layout and gradient. Methods of cleaning out pipes after use and associated problems are covered. On large pours not exceeding 700 ft. on one particular site, 17 yds.^{3} per hour was the rate of pumping dropping to 15 yds.^{3} per hour or less over 1,000 ft.

W.C.

Notes from *Civil Engineering and Public Works Review*, April, 1959.

Canadian Notes

Under the heading of "Unique Town on Stilts" is described the construction of a new Arctic town of Inuvik.

The construction problem was how to build on the permafrost without heat from the buildings melting the muskeg and allowing the buildings to sink.

The solution was to build on forest piles. Steam jets thaw the tundra, wood piles are driven to 20–25 ft. and in two to three hours they are frozen solid. The piles are cut off horizontally to provide a level base and leaving a crawl space underneath which is enclosed by the exterior walls.

Another novelty is the "utilidor", a rectangular insulated metal channel containing steam heating, water, and sewer lines.

New Treatment Works for Bedford

A description of a new treatment works, now under construction, incorporating the most up-to-date equipment is given on page 451.

The tanks, reservoir, filters, etc., are all founded on rock. The central administrative block is founded on reinforced concrete bearer beams spanning between piles, cast *in situ*, to prevent differential settlement.

QUALITY CONTROL IN FACTORY-MADE PRECAST CONCRETE

This paper deals with some of the problems peculiar to factory produced concrete. Besides touching upon the principal factors involved, namely, materials, workmanship, and testing requirements, an analysis is made of a number of cube results taken over a period of years. Comment is made on principles of fixing target strengths for cube results and conclusions are drawn as to the suitability of different batching methods. W.C.

THE MILITARY ENGINEER

Journal of the Society of American Military Engineers

JANUARY–FEBRUARY, 1959

"Nuclear Development in Continental Europe," by Captain Fred F. Kravath, Civil Engineer Corps, United States Navy

Captain Kravath described the state of Nuclear Development in Great Britain in an article in the November–December number of the *Military Engineer.* This article is an equally clear and complete account of the situation in the remaining countries of Europe. He points out that the energy needs of Europe can only be partially met by exploiting internal resources, water power, coal and oil and that there will always be an increasing need for oil and coal imports unless nuclear energy can be developed to fill the gap. He goes on to give a detailed account, country by country, of the work completed, in progress and planned. He concludes with a summary of the various international bodies such as Euratom which are engaged in collaboration. His study of the subject makes him suggest that the need to make the widest use of nuclear energy provides a strong motive for ever closer co-operation between the nations of Western Europe possibly leading to political union. Without going quite so far as that there is no doubt that his article gives a clear picture of the co-operative effort which is being made which must in some ways bring the nations closer together.

"Pipe Line relocation in Korea," by Major Mark C. Carrigan, Corps of Engineers

The P.O.L. pipe line system at Inchon in Korea connecting the tanker anchorage to the tank farm storage areas and the distributing centre was laid under operational conditions about seven years ago. The lines had become badly corroded in several places and also they ran circuitously through parts of highly populated Inchon and adjacent villages. It was considered essential to re-aline the system, both to shorten it and to avoid the built up areas. The re-alinement involved laying the pipes across two tidal flats 1,100 ft. and 3,000 ft. long respectively. Eight lines of 8-in. pipe had to be laid and when it is realized that the tidal flats are submerged to a depth of over 30 ft. twice every twenty-four hours by one of the highest tides in the world the difficulties involved can be appreciated. The article describes how the work was carried out with ample technical detail and illustrations so that it is a valuable paper at once interesting and instructive.

"Largest Rocket Test Stand. Edwards Air Force Base. California," by Robinette E. McCabe

The U.S. Air Force Research and Development Command is carrying out an extensive study of the problems involved in Rocket Propulsion for engines and missiles. Part of the work includes static rocket engine tests which are being conducted at Edwards Air Force Base in the Mojavie Desert, California.

This article is a description of the design and construction methods employed for the erection of a test stand capable of statically testing future missile systems and rocket engine plants developing 1 million lbs. of thrust. Apart from dealing with the very large forces involved, protection has to be provided against the powerful propellant blast. The test platform consists of a reinforced concrete cantilever anchored some 60 ft. into solid rock jutting out from a cliff face which allows for the great depth needed for flame deflection. The cantilever construction was found to be the best type of structure to counterbalance effectively the extremely high dead loads imposed by the test vehicle and the upward thrust of up to 1 million lb. during the actual firing because the missile or engine components are anchored securely to the test stand.

The project includes instrumentation and control buildings, suitably constructed to withstand the shock of the firing, workshops, stores, etc. The total cost of the Edwards Air Force Base is given as $50 million and of the rocket test part $10,105,000. The article is well illustrated with clear technical details and makes one realize the immense amount of research, experiment, and expenditure needed before a space rocket can be successfully launched.

"Army Polar Research and Development," by Colonel Hubert E. Klemp, Corps of Engineers

The U.S. Army has been carrying out extensive research into the problems involved in operating in the Arctic and the Corps of Engineers has been participating, particularly in the improvement of construction techniques, making use of indigenous materials, snow, ice, and frozen ground. In 1958 the U.S. Army Polar Research and Development Centre was formed, with its headquarters at Fort Belvoir, under the command of the Chief of Engineers, to provide support to Army Polar Research and Development and other related activities in Greenland and other Polar areas. The centre provides engineer field, works, and transportation services and also provides technically qualified personnel to work directly for various research projects.

This article describes briefly a number of research projects in hand against a background description of the local conditions of climate and terrain. Among the items are the development of a thermal imaging device which is to be mounted in a helicopter for crevasse location and mapping. Snow structures, ice tunnels and pile testing are also described.

"The Braddock Campaign, 1755. Part I. Purpose and Preparation," by George T. Ness, Jr.

An account in considerable detail of the initiation of the campaign against the French in America which ended in General Braddock's disastrous advance to and retreat from Fort Dusqusne. It will be continued in succeeding numbers of *The Military Engineer.*

"Engineer Underwater Operations," by 2nd Lieut. James L. Cleary

A very interesting paper on the above subject with accounts of salvage and other operations carried out by Engineer Corps divers in Korean waters.

"Inter American Transport Program," by Colonel Raymond L. Hill, Corps of Engineers

This article completes the story of the development of communications between North and South America, Cuba and the Caribbeans, which was begun in the article entitled "The Pan-American Highway" by the same author in the Nov.–Dec. number of *The Military Engineer*.

"Engineers in the Pacific Theatre," by Brigadier-General Philip F. Kromer, Jr., U.S. Army, Colonel Charles V. Ruzek, Jr., Corps of Engineers

This is an account of the Engineer organization and work in the Pacific Theatre which includes Japan and the Islands. There is an interesting account of the use of precast reinforced concrete beams for the construction of bunkers in field defences to provide durable works which are also economical to build. Every part is light enough to be carried by two men over rough going. Another interesting item is an account of the extensive survey and map-making programme which is being undertaken.

"An Engineer's view of Moscow," by Captain Elliott B. Roberts, U.S. Coast and Geodetic Survey

An interesting short account of Moscow by an Engineer attending a conference on the International Geophysical Year which is frightening in the way it brings out the immense drive which is behind the Russian determination to outstrip the West.

"Survey and Maps"

This section contains much of interest to Surveyors and a short historical account of the surveying of Alaska and charting the adjacent waters.

MARCH–APRIL, 1959

"Geopolitics and National Power" by Captain William T. Greenhalgh, United States Navy

Captain Greenhalgh discusses the philosophy behind the United States foreign policy in the light of the history of geopolitical theory since the publication of Mahan's *The Influence of Seapower upon History* until the present day. Mahan maintained that a nation's wealth and prosperity depended on a large and prosperous trade for the protection of which a strong navy was essential. A country which had no land frontiers needing large ground forces was at a great advantage in this respect, and the powerful position of Great Britain supported his argument. He foresaw that the United States, similarly free from the need of land frontier defence, would, in time, succeed Great Britain.

This theory was questioned by Sir Halford Mackinder who published *Democratic Ideals and Reality* in 1919 in which he contended that dominating power in the world would come to the power which, first held the interior of the Eurasian land mass, which he called the Heartland, and then the maritime outer region which he called the Coastland. Hitler was strongly influenced by this theory.

Later writers have pointed out that the real source of power rests in Mackinder's Coastland rather than the Heartland, from which the American policy of containment naturally follows. Only a sketchy outline of the argument is given above, Captain Greenhalgh develops it at length without wasting any words and he gives a clear presentation of the policy which should be followed and the action which should be taken by the United States and the other Western Powers.

"T.V.A. Communication Facilities," by G. E. Farmer

The Tennessee Valley Authority electric generating system has a generating capacity of more than 10 million kW and is part of an interconnected power system of 70 million kW through thirteen major connections with neighbouring companies.

This article describes the communication system which has been developed for the operation of the power system.

"Removal of the Roosevelt Bridge," by Loran W. Olmstead and Colonel Rockner E. Burns, Corps of Engineers

An interesting, well illustrated account of the removal of the Roosevelt Bridge spanning the South Cornwall channel of the St. Lawrence River as part of the work made necessary by the development of the St. Lawrence Seaway. The bridge consisted of three arched truss spans with a 62-ft. girder approach at both ends. The plan included floating out two of the spans prior to dismantling by cutting the steel with acetylene torches. The design of the floats, jacking methods, the dispositions of the ancillary plant, and the methods used for control during the floating operation are clearly described.

"Construction—Vital to Security," by Major-General Emerson C. Itschner, Chief of Engineers, United States Army

The Chief of Engineers has written a short Editorial emphasizing the great tasks facing the Engineer Corps at the present moment, particularly in respect of defence works of all kinds, and the still greater tasks which would face the Engineering Industry of the country in the event of nuclear war. He makes a strong point of the necessity for close co-operation between the Engineer Corps and the Contracting industry. This editorial brings out the important part which the Engineer Corps plays in the Engineer world of the United States.

"The One and Only"

A very brief but interesting note on the organization and equipment of the 618th Engineer Company (Light Equipment) Airborne. All the equipment can be carried by air. Much of it is still in the experimental or test stage and specially designed to be within a 16,000-lb. weight limit. The usefulness of the unit has been demonstrated on large-scale exercises in Germany. The personnel of the unit are all qualified paratroopers.

"Pneumatic Breakwater Development in England," by William A. Heath

The feasibility of reducing a heavy and dangerous sea to a comparatively light one by distributing compressed air upwards from a system of under-water pipes has been known for a long time and experiments were carried out in the hope of using the method in Mulberry. The experiment was not sufficiently successful at the time but in 1952 a company was formed to carry out research and development on behalf of British Railways with the object of providing a temporary pneumatic installation at the Dover train-ferry dock to protect the inner dock gate when the outer gate was removed for repair. The article describes this project and the design and operation of the pneumatic breakwater stretching 300 yds. across the mouth of the inner basin now operating at Dover harbour.

"Army Engineer Division Laboratories. Annual Conference"

The object of these conferences, which are attended by representatives from the several continental divisional laboratories of the Corps of Engineers, is to co-ordinate and standardize test procedure, exchange ideas for operational improvement and discuss research and special projects.

Notes are given on the subjects discussed which contain much of interest:—

Relation between Length Change, Moisture Content and Equilibrium Relative Humidity of Concrete Masonry Units.

Electronic Data Handling System for Consolidation Testing of Soils.

Comparison of Compaction Data Developed by Various Types of Mechanical and Hand Compaction Hammers.

"The Braddock Campaign 1755." Part II. Wills Creek to the End," by George T. Ness, Jr.

A detailed account of the advance and defeat of General Braddock's force at the Battle of the Monongahela. A third Part "The Aftermath" will complete the account in the next number of *The Military Engineer*.

"Refrigerated Foundations in Permafrost," by Major Donald H. Henderson, Corps of Engineers

In the construction of the Air Base at Thule in Greenland the major construction problem was to provide stable foundations in the permafrost which is the permanently frozen ground. Any appreciable addition to the surface heat may result in a permanent lowering of the top surface of the heretofore permanently frozen subsoil.

The article describes the methods employed to deal with this problem with particular reference to the construction of Nike installations round the air base. In this case a special refrigerating system was designed to stabilize the foundations.

"A Framed Structure without Sheathing," by E. George Stern

A detailed description of a method of constructing the walls of a building using prefabricated panels consisting of sheets of ribbed tempered hardboard batten boards with the battens forming an integral part of the board and providing supplementary strength and rigidity. A feature of the design is the set of specially designed nails which at once give increased strength for a less total weight of nails than conventional timber frame and sheathing. This new method might be worth study.

"Salt Cavern for Petroleum Products," by Edgar W. Muir

The U.S. Air Force has been exploring new methods of fuel storage with the object of economy and providing protection. This article gives a brief description of the use of natural caverns, quarries and stabilized soils but the main subject treated is the construction and operation of storage spaces in underground salt deposits. The cost compares favourably with conventional storage and, of course, there is very much increased protection and concealment. Salt caverns may be of only limited feasibility in this country but the other methods touched on might be worth examining.

"Surveys and Maps," by Engineer Research and Development Laboratories. Lorac Survey System

A description of an electronic survey system developed by The Lorac Service Corporation, Tulsa, Oklahoma, which can be used to measure distance and ascertain position when line of site conditions do not exist. It has potential value for Engineer and Artillery Survey.

J.S.W.S.

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, December, 1958.

Engineering Education

The first two papers in this issue deal rather generally, and from slightly different aspects, with the Canadian approach to the problem of training professional engineers at this time of rapid expansion of scientific and technical knowledge.

The problem is being faced in different ways in many countries, and anyone who is interested in the subject will find here much that may stimulate his own thought. The trends apparent in Canada indicate that there is now a closer parallel between the educational requirements of civilian and of military engineers.

Modifications to the Jacques Cartier Bridge

As part of the St. Lawrence Seaway project, the Jacques Cartier Bridge at Montreal had to be modified to provide the specified 120 ft. vertical clearance above the waterway. The selected 245-ft. span had to be raised 83 ft., of which 33 ft. were gained replacing the original deck span by a through truss. The remaining 50-ft. clearance was obtained by changing the profile of the roadway, by jacking up fourteen spans and building up the piers by varying amounts.

At the south abutment the roadway level had to be raised by nearly 27 ft., and it was found necessary to extend the bridge by providing an additional 65-ft. span and a new abutment, altering the old abutment to serve as a pier while still retaining the original fill. As the bridge, carrying some 35,000 vehicles per day on four traffic lanes, had to remain in use with minimum interruption of traffic, four separate Bailey bridge lanes were used as detours while this work was in progress.

Planning and construction are described in some detail in this clear and well illustrated paper, which is in the main a noteworthy exposition of the art of jacking.

Notes from *The Engineering Journal of Canada*, January, 1959.

Underground Hydro-Electric Power Stations

Some 300 underground hydro-electric power plants are now in operation or under construction in about thirty different countries. The total installed capacity is about 31 million kW, and roughly the same capacity is in the planning stage.

It is a common fallacy that underground plants are so built for reasons of security against aerial or nuclear attack, but the real reasons are economic and to some extent technical.

This comprehensive and clearly illustrated paper deals briefly with development history and the present extent of underground installation, and discusses the economical and technical aspects, design considerations, and operating experience. The author's conclusions are very clearly summarized.

Plastic Behaviour of Steel Frames

Previous papers in *The Engineering Journal* have expressed divergent views on the practical application of the plastic theory of design to steel and reinforced concrete structures (see *R.E. Journal*, March, June, and December, 1957).

This short paper describes a limited series of tests made on beams and simple frames of standard rolled steel sections. The author claims that they demonstrate beyond doubt that the plastic theory can be applied to large frames built up of rolled structural shapes, but he concedes that lateral movement must be prevented.

The elastic design method, criticized as uneconomical, often results in columns that are too flexible. It still appears to be open to question whether plastic analysis affords practical improvement in the design of modern, lightly-clad building frames.

Notes from *The Engineering Journal of Canada*, February, 1959.

This issue contains five papers which, while not of particular concern to the military engineer, provide interesting information in diverse fields. The subjects are:—

(*a*) *Fifty years of aeronautical engineering.*—This is a symposium by Canadian experts, to mark the fiftieth anniversary of powered flight in Canada. Though historically parochial, the story of progress in various branches of aircraft design and construction makes interesting reading.

(*b*) *Engineering features of the Beechwood Development.*—Hydro-electric power installations seem to grow naturally in Canada. This paper, more technically written than most dealing with such projects, gives a particularly clear impression of the need for meticulous planning, especially as regards hydrology and foundation treatment. The electrical side of the power-house is fully described.

(*c*) *Beechwood Kaplan Turbines.*—Hydraulic and mechanical features of the Beechwood generating equipment are described. This paper is better suited to the technical expert than to the general reader.

(*d*) *Methods and trends in automatic combustion control.*—This is a lavishly-illustrated and well arranged review of control systems for oil, gas, and alternative-fuel boilers. Trends in automation techniques and desirable research are briefly discussed, and the human element is not overlooked.

(*e*) *The role of the technical assistant in industry.*—Much has been said and written about the shortage of scientists and qualified engineers in this age of dramatic technological progress. The increased use of "technical assistants" is often suggested. This paper is a practical attempt to analyse the problem, and to suggest functions and required standards.

Notes from *The Contract Journal*, August, 1958.

A LAWYER CONSIDERS: CLAUSE 18 AND THE RIGHT TO EXTENSION OF TIME

This article cannot be condensed. Officers controlling contracts are strongly advised to read the full text, which sets out many of the legal aspects of a very knotty problem—what right has the contractor to an extension of time?

PRESTRESSED CONCRETE BRIDGES IN NEW ZEALAND

Contractors have been encouraged to try prestressed techniques by the system of tendering employed by the New Zealand authorities for 140 new bridges. The tenders were divided into parts—piling, precast units, transport and assembly, stressing and grouting. The units were ordered separately, to standardized dimensions, on a "supply only" basis, so that the site engineer had only the risk of stressing to allow for. By this means, 134 of the bridges were tendered for and won on the prestressed system as against the conventional methods, which were set out as an alternative scheme.

The precast units, generally T-beams, averaged 3–6 tons each. Ducts were formed using steel shafts covered with rubber hose. Steel moulds were vibrated on large tables, assisted by internal vibrators where necessary, and concrete with a twenty-eight day strength of 5.550 lb. sq. in. using calcium chloride gave a daily turn round of moulds. (Note that U.K. practice is now averse to the use of calcium chloride because of its corrosive danger).

Permissible tolerances were:—

Overall length	$+ 0; - \frac{3}{8}$ in.
Flange width	$+ \frac{3}{8}; - \frac{3}{8}$ in.
Width of web	$+ \frac{1}{8}; - \frac{1}{8}$ in.
Position of long ducts	$+ \frac{1}{8}; - \frac{1}{8}$ in.
Remaining dimensions	$+ \frac{1}{8}; - \frac{1}{8}$ in.

Twist not specified, but carefully examined.

Transporting the units up to 150 miles was found to be economical.

A team of four men, with handling equipment, assembled, stressed and placed the beams at the rate of six tons per man per day on average.

Notes from *The Contract Journal*, September, 1958.

Applications of Work Study in Municipal Engineering

The author draws attention to benefits which have been derived from the application of works study methods to "jobbing engineering". The article is worth study by all who employ DEL.

It is well known that a good incentive system can benefit both the employer (by a net reduction in cost) as well as the workman, by increasing both the workman's wage packet and his self esteem. The difficulty has always been to organize a fair system of rate fixing and time fixing. Work study is no fairy wand, and means introducing an additional function into the organization for which previously there was no precedent.

The article describes how some of the preliminary negotiation to start a scheme can be handled and quotes some valuable rules. These are repeated below:—

"(*a*) The starting level must be such as to be achievable reasonably by the average operative without an immediately disproportionate increase in effort.

(*b*) The full incentive rate must be sufficiently attractive to ensure that: (i) the present (operatives) would be encouraged to achieve the required output; (ii) new young employees would be attracted to the gangs.

(*c*) A reasonable reduction in unit labour costs must be achieved irrespective of bonus paid."

The system is based on assessing fair times for work and fair allowances for delays, travelling, setting out jobs, sharpening tools, clearing up, etc. These are based on timing a number of jobs (it is to be noted that stop watches were barred as being bad for morale!) Job cards are made out totalling up the time allowed on measurable work, added to actual time on jobs not targetable. All time "saved" by the operative then counts towards his bonus at an agreed scale. This allows a credit to both the man and his employer. Typical results for bricklayers and joiners quoted showed a weekly increase of over £2 per man and still resulted in 20–30 per cent reduction in overall cost.

The article does not show what happens when a "target" is over-reached—but it seems that, if properly applied to jobs that need gingering up, such contingencies do not arise. Certainly management, having started the ball rolling, must keep up with the gangs working for a bonus by adequate planning and organization.

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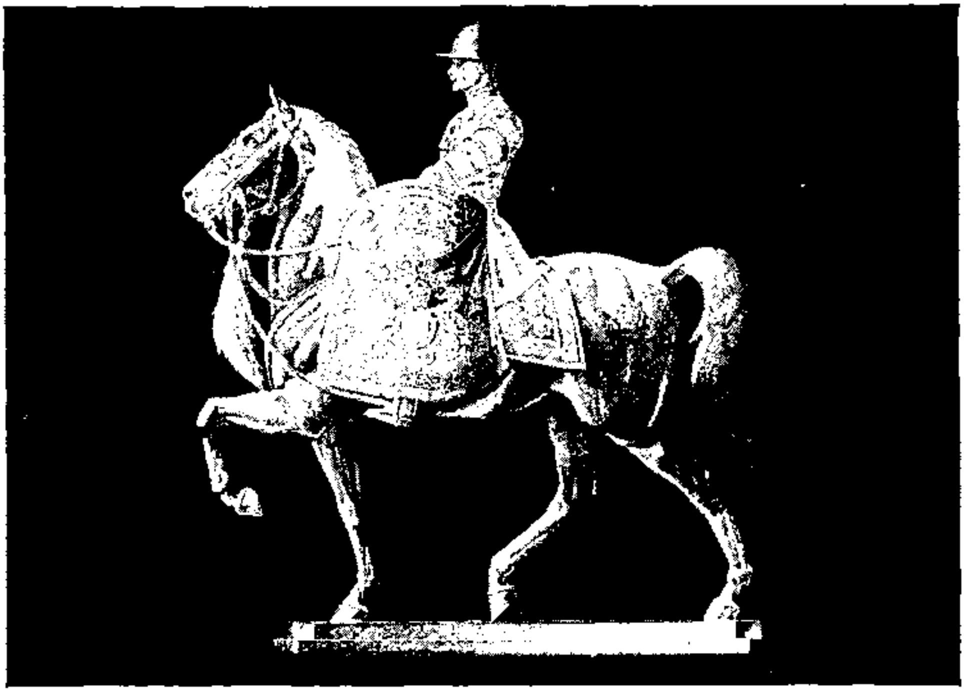
T.W.T.



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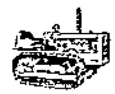

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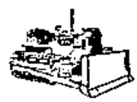

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