THE ROYAL ENGINEERS JOURNAL

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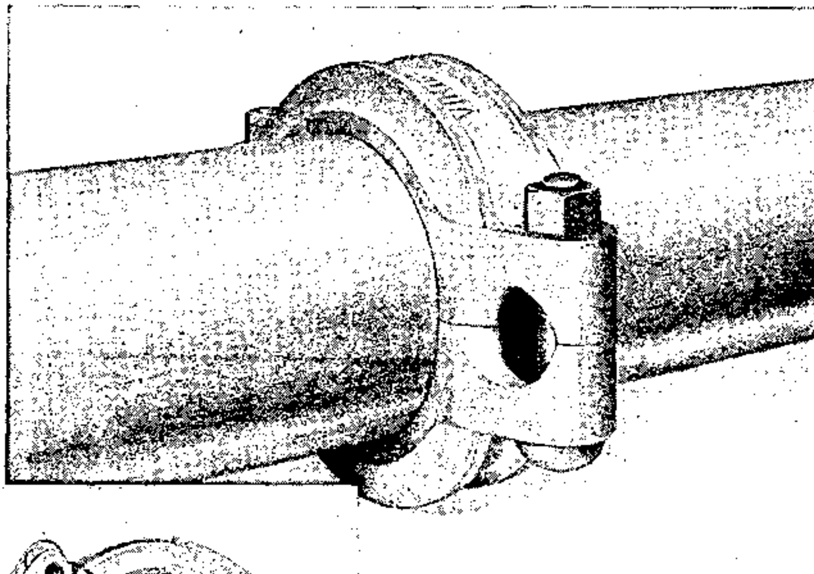

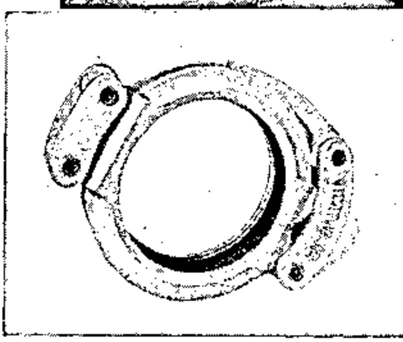

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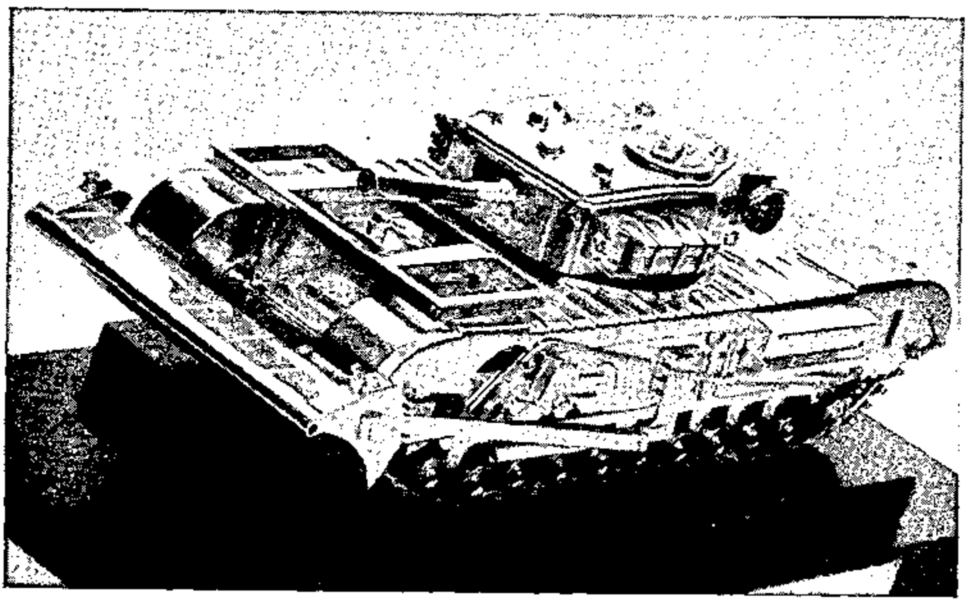

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Corps Notes

It is with the deepest regret that the deaths are announced of General Sir Cecil Sugden, GBE, KCB, Colonel Commandant RE, lately Master General of the Ordnance, Major-General Sir Charles Gwynn, KCB, CMG, DSO, a previous Commandant of the Staff College, Camberley and President of the Institution of Royal Engineers from 1938 to 1941 and Major-General G. R. Turner, CB, MC, DCM, CD, a most distinguished Royal Canadian Engineer Officer. Their Memoirs are published in this *Journal*.

* * * * *

Lieut-General Sir Charles Jones, KCB, CBE, MC, has become Master-General of the Ordnance and Lieut-General Sir Charles Richardson, KCB, CBE, DSO, has succeeded Lieut-General Jones as General Officer Commanding-in-Chief Northern Command.

* * * * *

Major-General G. W. Duke, CB, CBE will take over as Engineer-in-Chief from Major-General T. H. F. Foulkes, CB, OBE, in July.

* * * * *

Mr R. C. Bond, MICE, MIMechE, has been elected President of the Institution of Mechanical Engineers for the ensuing year. He holds the rank of Lieut-Colonel in the Engineer and Railway Staff Corps, Royal Engineers (TA).

The late Major-General A. E. Davidson, CB, DSO, Colonel Commandant RE, who died in January 1962, was President of the Institution of Mechanical Engineers in 1935/36; he was at that time still on the Active List and he was the first serving officer ever to receive that greatly coveted mark of honour and significant recognition of professional standing.

* * * * *

39th Field Squadron celebrated its centenary on 9 November 1962 at Osnabruck, the ceremonies were conducted in the presence of the Representative Colonel Commandant, Major-General G. N. Tuck, CB, OBE.

* * * * *

42nd Survey Engineer Regiment is due to return to the United Kingdom from Cyprus in June; the Regiment will be stationed initially at Barton Stacey. 32nd Field Squadron, which forms part of 38 Corps Engineer Regiment, is now deployed in Aden; the unit is due to return home at the end of the year when it will be replaced by 12th Field Squadron. 54th Field Squadron is now reorganized as 54th Corps Field Park Squadron in Singapore. 59th Field Squadron, recently reformed as the third squadron of 36 Corps Engineer Regiment, is due to raise its last troop in October.

* * * * *

In December last the OC 54th Corps Field Park Squadron became OC RE Brunei and controlled all the engineer work in the area of operations. He had under him 69th Gurkha Independent Field Squadron, employed on road and track maintenance, the building of extensions to an existing air-strip and the operation of improvized ferries; 54th Corps Field Park Squadron employed on developing the Brunei airfield runway, operating water points and assisting the local Public Works Department; 10th Port Squadron who were responsible for the loading and unloading of LSTs and LCTs and the operation of Z Craft and a Works Section who also assisted the PWD.

* * * * *

The Area Works Officer and a small RE Detachment in Cyrenaica provided emergency lighting and mechanical equipment to clear blocked roads after the Barce earthquake.

* * * * *

24th Field Squadron is training in Canada, one of its tasks has been the building of a tank track including the construction of a timber bridge and culverts.

* * * * *

The Seventh American-British-Canadian-Australian (ABCA) Engineer Conference will be held this year at the Royal School of Military Engineering, Chatham; it will be the first time that Royal Australian Engineers will take part in the Conference.

* * * * *

For some time now there has been a move towards greater integration of the Army's research and development activities. One outcome has been the setting up of an independent Scientific Advisory Council directly responsible to the Army Council. As a result of discussions with the Chief Scientist at the War Office, the Engineer-in-Chief came to the conclusion that the work of the Royal Engineer Advisory Board could be carried out more effectively if it had some direct link with this Scientific Advisory Council.

The REAB has, therefore, been disbanded and a new Royal Engineer Advisory Committee formed as an agency of the Scientific Advisory Council. The terms of reference of this Committee are to consider and advise on problems of research and development in the field of military engineering and to advise on the military application of modern engineering techniques, practices and materials.

Many of the representative professions and advisors contained in the old Advisory Board continue to be represented on the Committee, but the scope has been widened to include additional representation from the Universities and in the fields of electronics and petroleum engineering.

* * * * *

Dress Instructions for Other Ranks of the Corps are in course of preparation and they will be issued before the end of the year.

* * * * *

After a rather poor start in January, Other Rank recruiting improved slightly in February and March. However, owing to the recently increased allotment of manpower to the Army there is still an urgent need for recruits of the right calibre. Other Rank recruiting will continue to be a high priority task at least until the end of this year. Our Special Recruiters continue to do a very good job, but more volunteers are needed. There are signs of a slight improvement in officer recruiting, but we are still falling far short of our target. No opportunity of encouraging suitable young men to join the Corps should be lost. A large number of both Regular and Short Service Commissioned young officers is urgently needed.

* * * * *

With effect from 1 April 1963 the responsibility for Works Services required by the War Department in peace was transferred from the War Office Works Organization to the Ministry of Public Buildings and Works.

* * * * *

2nd Lieut J. A. G. Prior became Heavyweight Boxing Champion of the Army at this year's Army Individual Boxing Championships, and he represented the Army in the Inter-Services Championships. Although Sapper officers and Other Ranks have become Army and Inter-Services Boxing Champions in the past, the Army Heavyweight title has not been held by a Sapper since it was won by Captain F. E. Buller, OBE, MC in 1921. He came home from India on leave to take part in the Championships.

In the ISBA Championships 2nd Lieut Prior knocked out his RAF opponent but was beaten by Corporal Sanders, Royal Marines, representing the Royal Navy, who went on to win the Amateur Boxing Association Heavyweight title. Lance-Corporal R. Rae, of 1 Training Regiment RE, won both the Army and the ISBA Flyweight titles. In the ABA Championships he reached the Semi-Finals where he was beaten on points by the eventual winner of the Flyweight title.

* * * * *

Another historic link with the past disappeared last March when the balloon shed in Balloon Square, Gibraltar Barracks, Aldershot, built in 1892, was pulled down to make way for new barrack accommodation. The occasion was marked by a parade of two parachute detachments and an RAF detachment. Also on parade was a replica of an early RE Balloon, piloted by an RAF Wing Commander and carrying as observer and aerial photographer an officer from 9 Independent Parachute Squadron RE and a girl with a camera. When the moment came for the balloon to ascend from its moorings it scattered its handlers with a sudden jerk, removed a corner of the shed roof and narrowly missed a chimney stack, then to the strains of "Will ye no' come back again" it sailed capriciously upwards and, escorted by a helicopter, it eventually landed in a field near Mytchett after a flight officially described as "uneventful". The parade was watched by Brigadier F. R. S. Gervers, CIE, CBE, aged 90 years and a RE balloonist at Aldershot in 1900. He probably thought that things were done rather differently when the Royal Engineers were solely responsible for military flying.

* * * * *

Having successfully completed the task of blasting passages through the coral reefs around the Gilbert and Ellice Islands, the RE detachment from 36 Corps Engineer Regiment returned home to Maidstone in December 1962. As a token of their appreciation of the friendship and help extended to them by the islanders the RE detachment presented each of the islands with a shield bearing a replica of the Corps cap badge in colour.

To commemorate the association of the Corps with Christmas Island an illuminated plaque was installed in the porch of St George's Church on the island last February.

* * * * *

Mrs E. Hunt of Burton House, Marsham, Yorks has presented to the Headquarter Mess a portrait of her grandfather Major-General The Right Hon Sir John Cowell, KCB, a most distinguished Sapper officer who served with great gallantry in the Crimean War. He was with Corporal W. J. Lendrim of the Royal Sappers and Miners when that NCO was awarded the VC for extinguishing a burning magazine under fire on 11 April 1855. On retirement he became Master of the Royal Household which post he held until his death in 1894.

* * * * *

The Longmoor Drama Group has won the Army Drama Festival for the second year running. The Group's entry, Peter Ustinov's *The Love of Four Colonels*, was presented at the Scala Theatre, London on 29 April last.

* * * * *

One of the subjects set for this year's Trench Gascoigne Prize Essay is an extract from the speech made by HRH the Duke of Edinburgh when he laid the Foundation Stone of the new barracks at Chattenden during his visit to the Royal School of Military Engineering last July. It reads: "*Any idiot can go on doing what has been done before, but it takes real courage, intelligence and character to assess the needs of the future, to devise a sound programme and carry it into effect. This is particularly true of the Armed Services, which become merely an expensive luxury unless the process of improvement, modernization, forward thinking and planning goes on continuously.*

What improvements in organization and administration jointly affecting all three services do you consider could and should be made during the next five years?"

It is surely up to the Corps to provide the winner of this year's Prize.

Instantaneous Soil Stabilization by Electro-osmosis—Fact or Fantasy?

By CAPTAIN J. R. BAINBRIDGE, MA, RE and
K. H. ROSCOE, ESQ., MC, TD, MA, AMIMECHE

FOREWORD

MR K. H. ROSCOE is the head of the Soils Mechanics Laboratory at Cambridge University and is a member of the RE Advisory Committee. From 1958–61 he was a member of a special panel which was set up to investigate possible ways of constructing rapid approaches to military bridges. During the course of the panel's deliberations, he put forward the suggestion that electro-osmosis might have some application in this field and it was accordingly arranged that Captain J. R. Bainbridge RE should be made available to carry out research work on this project at Cambridge.

INTRODUCTION

This paper describes a project in which an attempt was made to check a hypothesis that electro-somotic methods may be used to cause rapid stabilization of soft clays. Previous experimental evidence suggested that the hypothesis could be tested in a relatively short space of time, with the minimum of equipment and expense. In view of the possible military applications of the method, it was arranged that a sapper officer should undertake a brief period of research from November 1961 to May 1962 and a final month in January 1963 at the Soil Mechanics Laboratory of the Cambridge University Engineering Department.

The grateful acknowledgements of the authors are due to the Head of the Department, Professor Sir John Baker, OBE, FRS, MICE, by whose kind permission the project was performed at Cambridge. The apparatus was provided by the department and constructed in the laboratory workshops.

The opportunity has been taken in the course of the paper to review the known facts of the phenomenon of electro-osmosis, with some reference to current theories. Little attempt has been made, however, to discuss the military significance of this method of soil stabilization.

THE IDEA BEHIND THE PROJECT

Electro-osmosis, as a means of stabilizing limited volumes of soil, has been used in Civil Engineering practice since 1939. In that year Leo Casagrande applied the results of his previous laboratory experiments to the problem of an unworkable section of cut during railway construction at Salzgitter, in Germany.[1] The basis of the process was the removal of water from a soil mass by the application of a direct current. At Salzgitter a length of cut 100 yds long by about 15 yds wide, which was initially too wet for excavators to work, was stabilized by means of a direct current at a potential of 180 volts (later reduced to 90 volts) applied for a few days.

Since this early success the phenomenon of electro-osmosis has been used in civil practice all over the world. These civil applications have, however, been based almost entirely upon the concept of *dewatering* a soil in order to obtain stabilization. Success was achieved only after a period of several days. From the point of view of the military engineer this, in general, is far too long.

Attendant side effects of electro-osmosis suggested that an *immediate,* if temporary, stabilization could be obtained by placing a soil mass under the influence of an electric field. An attractive vista of possibilities opens up at the thought of a road across boggy terrain which can be created or destroyed by merely "throwing" a switch! Although such a state of affairs must at present remain a tactician's dream, electro-osmosis probably has a military potential which is as yet unrecognized.

The laboratory experiments already mentioned, and described in a later section, were entered upon with the intention of establishing whether sufficient *immediate stabilization* of clay soils could be attained by electro-osmosis to be of interest to the military engineer.

Some Facts about Electro-osmosis

When an electrical potential is applied across a soil mass, a movement of the water within the voids of the soil is induced. This pore-water movement is nearly always towards the negative electrode (cathode), though under certain circumstances it may be reversed and flow towards the anode—for instance, in chalky soil. The rate of discharge which takes place, under the influence of a given potential gradient, is very nearly the same for all types of soil, whether coarse or fine-grained.[1]

This phenomenon has been used widely for the dewatering of soil masses which it was impossible or uneconomical to drain by other means. Under normal circumstances it is of no advantage to apply electro-osmosis to sandy (coarse) soils, since such soils are easily drained by conventional methods. Clayey and silty (fine-grained) soils, on the other hand, benefit greatly from the electrical method, since they are almost impossible to drain by any other means.

In addition to the dewatering of the soil, a consolidation effect takes place, which is greater than would be expected from the simple removal of water from a saturated soil. Consolidation consists of a decrease in volume, an increase in density and a consequent increase in stability.

Since the stability of most natural soils is very sensitive to changes in moisture content, in many cases the foregoing effects are sufficient to stabilize a mass of wet soil. However, the process can take many weeks, or even months, to complete, and in these circumstances would be of practical value in few military engineering problems.

Particles of clay usually have positively charged ions adhering to their surface. These ions play an important part in determining the physical properties of the clay; for example a sodium clay (clay with sodium ions adsorbed) usually displays a severe tendency to swelling, in contrast to the same clay when calcium replace the sodium ions. It is therefore possible to change the properties of a clay by introducing an electrolyte containing ions of a different valency; the new ions can be made to displace those previously adsorbed.[2] Ionic exchange can be speeded up by the simultaneous application of an electric potential gradient to the soil. In one laboratory experiment a forty-seven-fold increase in the strength of a clay has been claimed by this means.[3]

Ion exchange also occurs when an aluminium anode is used in electro-osmosis. In addition, aluminium from the anode is deposited in the interstices of the soil in the form of aluminium compounds, which cement the soil particles together. Visible evidence of this is the extensive corrosion which takes place at the aluminium anode. The overall effect is to stabilize an area immediately adjacent to the anode. This has been used to increase the bearing capacity of aluminium-sheathed piles. The piles are connected as anodes for some days. The soil adjacent to the pile becomes dry and impregnated with aluminium compounds, which bind to the pile. The effective surface area of the pile is thus increased.

Electro-osmosis may not always be the cheapest method of dealing with a stabilization problem. It is often the quickest, and occasionally the only, method. Casagrande[4] gives as a practical guide to the consumption of electricity during electro-osmosis the following figures:

Large excavations	0.4 to 1.0 kWh/cu yd
Small excavations	10 kWh/cu yd.

It must be noted that these figures apply only to those cases where electro-osmosis is used with the intention of dewatering the soil, and where the removal of the water is the prime cause of stabilization.

Theories—Why Does it Happen?

The task of those who have attempted to form a satisfactory electro-osmotic theory has not been eased by the inadequacy and the conflicting nature of the empirical data available. There are however two main schools of thought.

The first attributes the phenomenon of electro-osmosis to the existence of an "electrical double-layer" (Helmholtz layer) which usually occurs at the interface of a solid and a liquid phase. The liquid forms a very thin layer adjacent to the solid; and this layer, which is negatively charged, behaves as if it were itself part of the solid. It is termed the "fixed layer". Next to this is a wider layer of liquid which is positively charged. (See Fig 1). If an electric field is placed across the system, the "movable layer", being positive, will try to move towards the negative end of the field, dragging with it the uncharged liquid in the middle.

The second main theory suggests that the movement of the pore water is due to the existence of the positively charged ions which are in the solution or adsorbed to the soil particles within a soil-water system. When in solution they act as nuclei to quantities of dipolar water molecules. These molecules, like tiny magnets, are positive at one end and negative at the other; the negative ends are therefore attracted to the ions. (See Fig 2.) When the system is placed in an electric field the positive ions travel towards the cathode, dragging with them their associated water molecules.

At first sight the outcome of the two theories would appear to be similar. The main difference is that according to the double-layer theory the quantity of water moved in a given time should be proportional to the applied voltage, whilst according to the Ionic Transport theory it should be proportional to the total electric charge passed. The protagonists of each theory produce empirical data to support their own line of thought. Further details of the theoretical aspect of electro-osmosis are discussed in a recent US Army review of the subject.[5]

Immediate Effects

One of the immediate effects of electro-osmosis is a change in pressure of the water within the pores of the soil. If the anode and cathode are maintained at atmospheric pressure, a substantial drop in pressure of the pore water has been observed within the soil mass and this has a significant effect upon the capacity of the soil to resist shear stress. A standard expression relating the pore-pressure (u) to the shear strength (s) of a soil is

$$s = c + (\sigma - u) \tan \varphi$$

where σ is the total normal stress

c is a cohesion constant, and

φ is often called the angle of internal friction.

It will be seen that for any soil obeying this relation, a reduction in u will increase the $(\sigma - u) \tan \varphi$ term, thus increasing s.

The reduction of pore water pressure which has been so far discussed takes a matter of hours to develop. Experiments in this field show that times varying between a few hours and several weeks may be expected before the maximum reduction is attained [6, 7]. A line of investigation which suggests a more immediate response to the imposition of the electro-osmotic gradient concerns the development of stresses within the soil skeleton as a direct consequence of the water movement. In plainer language: the water is forced one way—what is the effect of the presumed equal and opposite force on the soil?

The magnitude of the total forces on the water can be illustrated by considerations of permeability. A typical value for the hydraulic permeability of a clay is 10^{-8} cm/sec; that is, under a unit hydraulic gradient, the velocity of pore-water flow would be 10^{-8} cm/sec. But in all soils a potential gradient of 1 volt/cm produces a velocity of flow of about 0.5×10^{-4} cm/sec.[1] This means that a pd of 1 volt/cm has the same effect upon the pore water as a hydraulic gradient of 5,000 cm (over 160 ft) of water per cm run. In a more everyday illustration, if a sample of clay is taken 1 ft in length and a pd of 30 volts is applied, the flow of pore water produced would be the same as if there had been a drop in head of nearly 1 mile of water across the ends of the sample! (see Fig 3). There are clearly either tremendous stresses set up in the soil skeleton during electro-osmosis to produce the passage of water on such a vast scale, or else some sort of "lubrication" is developed between the water and the walls of the voids to permit the increased flow.

In addition to the permeability and pore-water tension phenomena, there is practical evidence to suggest that instantaneous forces are at work during electro-osmosis. If a metal pile is being driven into (or pulled out of) a clayey soil, the resistance to motion is greatly reduced by connecting the pile into an electrical circuit as a cathode. Conversely, the resistance to motion is increased by connecting it as an anode. This fact has been demonstrated both by laboratory and by field tests, carried out in Indonesia.[8] When an iron sheathed pile was being driven into clay during one test, the time for the pile to be driven through 1 metre (at 118 blows per min) was reduced from 13 min to 2.6 min by connecting it as a cathode. When connected as an anode the time increased to about 50 min. This effect, which is reported as instantaneous, seems likely to be caused by lubrication of the cathodic pile by the attracted pore-water, and an increase of friction at the anode due to instantaneous electro-osmotic forces between the anode and the surrounding soil grains.

Some simple tests which were designed to detect the presence, or absence, of instantaneous stabilizing effects of electro-osmosis will now be briefly described.

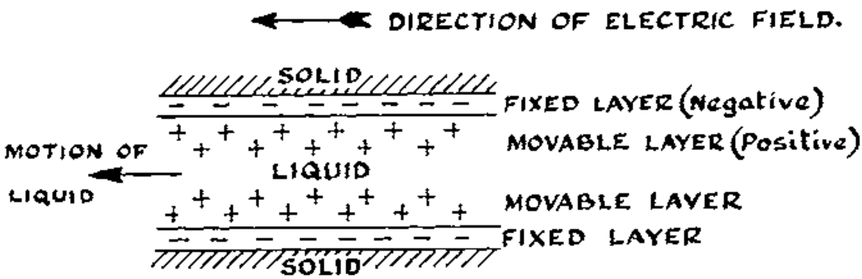

Fig. 1. DIAGRAMMATIC REPRESENTATION OF DOUBLE - LAYER CONCEPT.

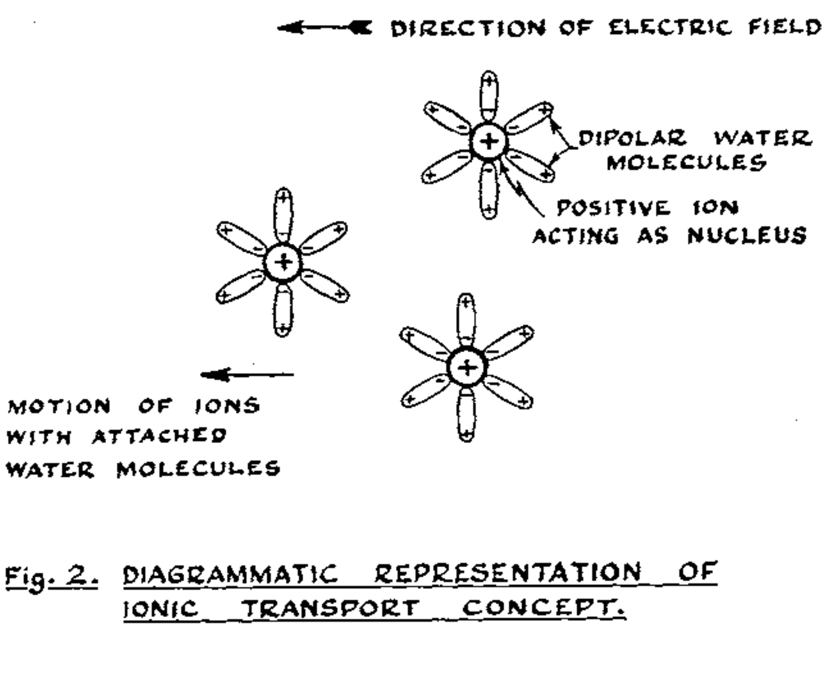

Fig. 2. DIAGRAMMATIC REPRESENTATION OF IONIC TRANSPORT CONCEPT.

Outline Description of the Tests

The material under test was Cambridge Gault Clay which was mixed in a pug mill to a wet condition (moisture content 62 per cent, liquid limit 80 per cent and plastic limit 30 per cent) in which it had only a small bearing capacity. In view of the short time allocated to the project, the apparatus had to be simple and capable of rapid manufacture. The equipment shown in Fig 4 was devised. The clay is contained in the perspex box and its shear strength is estimated at three points simultaneously by means of three penetrometers. The penetrometers have a common base *A* which can be mounted in various positions on the box. The feet of the penetrometers *B* can be forced into the clay by rotating the handscrew *C* and the loads on the feet were recorded by the dial gauges *D*. A typical load-penetration curve for one of the penetrometers is shown in Fig 5; a definite "failure load" is evident and this load is taken as a measure of the bearing capacity and hence the shear strength of the soil.

In Fig 4 the apparatus is shown set up for horizontal electro-osmotic flow between the aluminium electrodes *E* and *F*. With this method of test no instantaneous change of soil strength was recorded as the electrical current was switched on. However, it was verified that water was removed very rapidly from the clay near the anode. The drying of this clay caused its electrical resistivity to increase with a consequent development of a steep voltage gradient near the anode and a reduction in the rest of the clay. The steep voltage gradient then caused an even more rapid expulsion of the water and in a short space of time the clay in the anode region became extremely hard as shown in Fig 6. No significant effect was observed when chlorides of aluminium and calcium were added to the surface of the soil during electro-osmosis.

The restriction of the hardened soil to the locality of the anode led directly to another technique. In the new arrangement, shown in Fig 7, the anode was a mat *G*, of perforated aluminium sheet, covering the surface of the soil under treatment. The cathodes *H* were copper rods placed vertically alongside the mat, insulated from the clay except near the bottom of the box. This caused the potential gradient to be applied vertically downwards through the soil, drawing the pore-water from the surface down to the bottom of the box. Electro-osmosis caused a hard skin to form directly beneath the mat, below which was a layer of firm soil, and lower still the soil became progressively wetter as the cathode region was approached.

The voltage gradient applied during these tests was 2.5 volts/centimetre. The water escaped by bubbling up round the cathode rods, causing the edges of the hardened soil pavement to be weaker than the centre. When the excess water was drained off by means of a sand drain, the edges of the pavement were stronger, but there was little observed increase in the overall strength of the skin. The effect of a 2-hour and a 4-hour period of treatment, using this technique, is shown in Fig 8. The overall increase in strength for the shorter period of time is about 200 per cent.

Indications were obtained that the success of this technique might be reproduced on a larger scale, and could be applied to stabilization problems in the field. No larger scale tests, however, have yet been carried out.

The strength increases obtained by the "anode mat" technique were only achieved after treatment had been carried on for a few hours. It was still

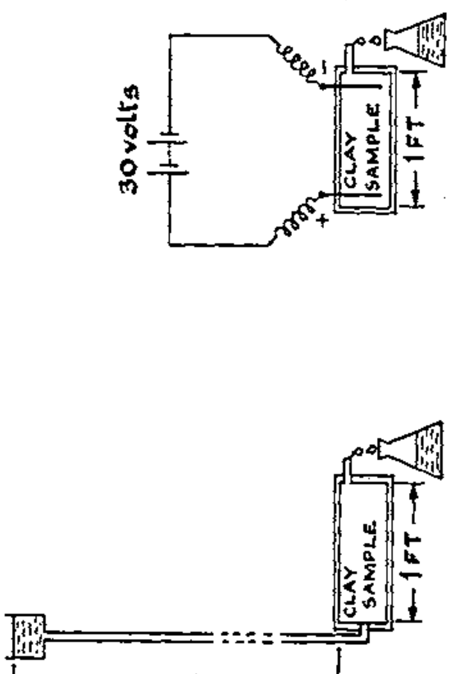

Fig. 3. EQUIVALENT EFFECTS OF HYDRAULIC AND ELECTRO-OSMOTIC GRADIENTS ON PORE-WATER FLOW IN A CLAY SAMPLE.

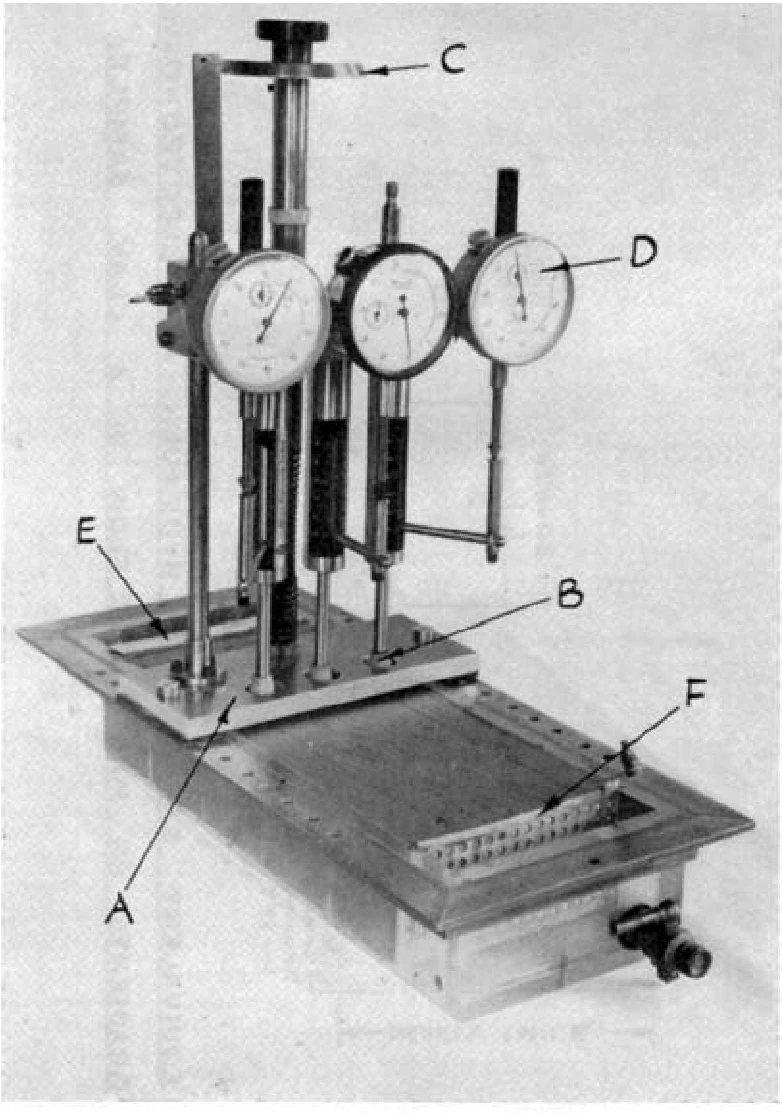

Fig 4. Penetrometer frame mounted ready for testing a sample of clay.

Penetrometer frame mounted ready to testing a sample of clay

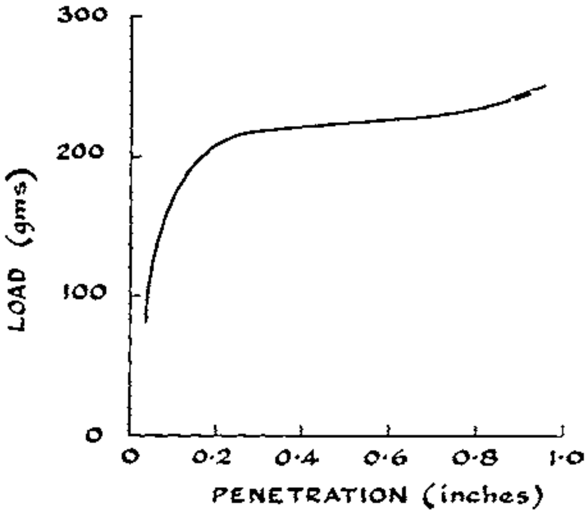

Fig. 5. TYPICAL LOAD – PENETRATION CURVE.

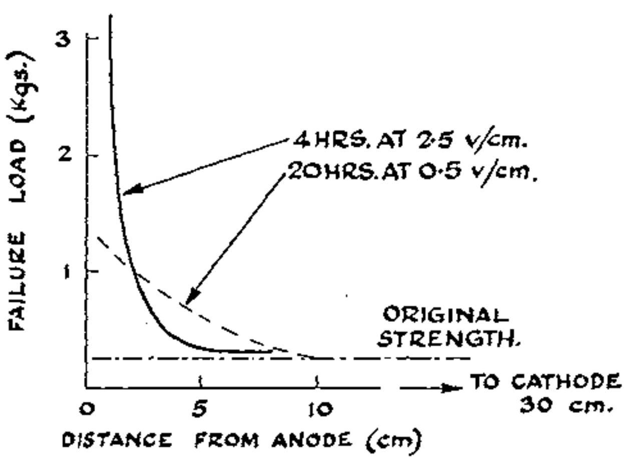

Fig. 6. EFFECT OF VARYING TIME AND VOLTAGE GRADIENT UPON SOIL AT ANODE.

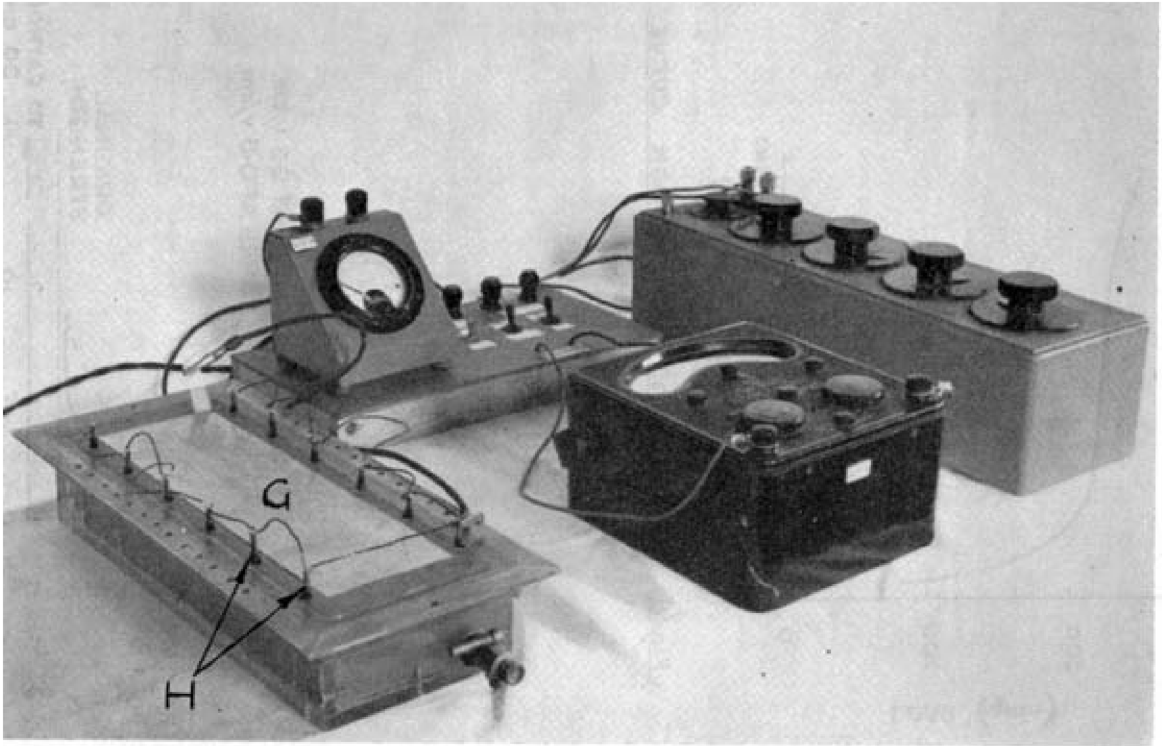

Fig 7. Mat anode (G) and rod cathodes (H) connected ready for treatment by electro-osmosis.

Mat anode and rod cathodes.

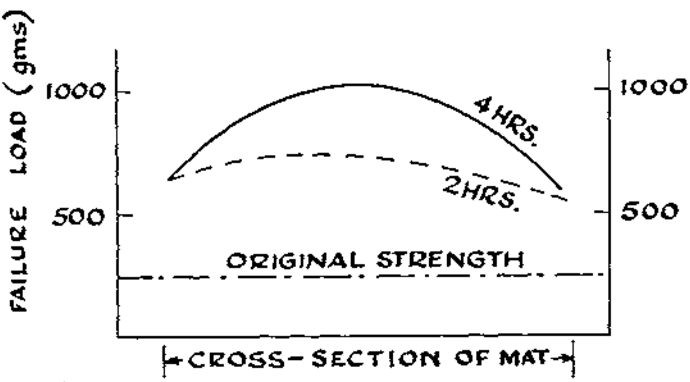

Fig. 8. EFFECT OF TIME ON SURFACE HARDENING BY "MAT" ANODE.

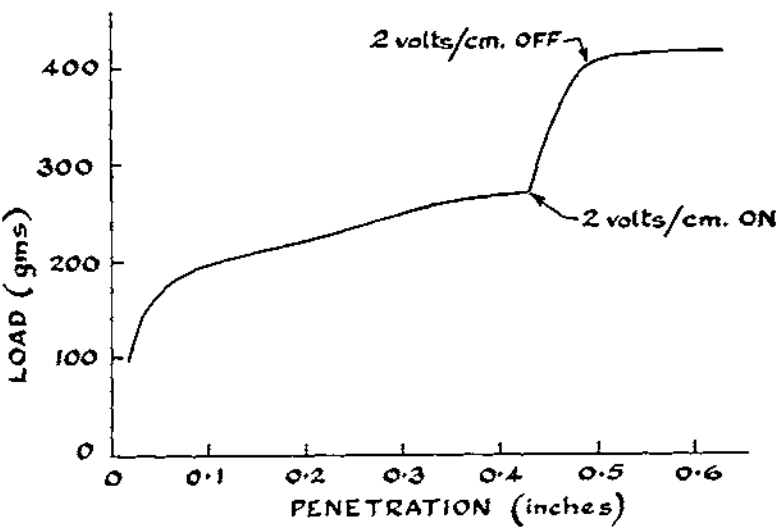

Fig. 9. INSTANTANEOUS EFFECT OF SWITCHING AN ELECTRO-OSMOTIC GRADIENT ON AND OFF DURING PENETRATION TEST.

hoped to obtain significant evidence of an instantaneous strength increase, either due to pore-water tension or to stresses in the soil skeleton as a reaction to the pore-water flow. For this purpose aluminium feet were made for the penetrometers. These feet were in the shape of inverted cones, so that contact with the soil occurred only at the base without side-friction. They were insulated from the apparatus and were wired into circuit as anodes. When a potential was applied to the aluminium feet the direction of the electric field within the soil beneath them was vertically downwards. It was surmised that the greatest instantaneous effect would be demonstrated under these conditions.

Tests using this latter arrangement showed that *there is an immediate increase* in strength due to an electric field. Fig 9 shows the effect of switching a potential gradient of 2 volts/cm on and off during a penetration test. The percentage increase obtained by this method was, however, disappointingly small. In a further test to failure, using a potential gradient of 1 volt/cm, the clay showed an immediate strength increase of 36 per cent.

The results of tests on a silt were very similar to those described above for clay.

Conclusions from the Tests

From the results of the experiments with this improvised equipment it may be concluded that:—

1. There is a detectable instantaneous increase in the strength of wet Cambridge Gault clay, when an electrical potential gradient is applied downwards through the soft soil mass. The magnitude of the increase depends upon the strength of the electric field, though no relation between these two parameters was established. At a gradient of 1 volt/cm the increase appears to be of the order of 36 per cent.

2. The rapid drying out of soil near an aluminium anode, during electro-osmosis, can be exploited by using an aluminium mat as the anode. This creates a stiff pavement of soil after only a few hours treatment, at a potential gradient which could be reproduced under field conditions (2.5 volts/cm–250 volts/metre). In a model test, the bearing capacity of Cambridge Gault clay was increased by a factor of 3 within two hours. This effect can probably be reproduced on a larger scale in the field.

3. Laboratory tests on a wide variety of soils, using more elaborate test equipment than described above, are needed before reliable conclusions can be drawn.

The Military Problem

Though primarily intended to be a factual report upon the phenomena associated with electro-osmosis, this paper would not be complete without a brief mention of the overall suitability of electro-osmosis to military soil stabilization problems.

Engineering projects are severely limited by difficulties of unstable terrain. In any task from assault bridging to route maintenance and construction, the choice of site is often largely dependent upon the feasibility of using a piece of ground with little or no preparation.

The reason behind this restriction is the shortage of time which always accompanies military enterprises. Tracking expedients provide a ready-made solution, but most are costly in labour and all throw an additional burden upon the supply system. What is needed is a means of stabilising an area of land quickly; at most, within a few hours. To date, the conventional means of stabilizing clay soil all require a period of days to take effect.

The requirements for the ideal process of soil stabilization for military purposes are as follows:—

1. *Speed.* The stabilization need not be permanent, but it must be quick. It must be quick to put into operation, and quick to take effect.

2. *Portability.* The equipment should be capable of being towed as trailers or carried on trucks.

3. *Simplicity and Safety.* The operating team should not have to include large numbers of highly skilled men. The equipment should be simple and reliable. The minimum of danger should be attached to operating the process.

4. *Re-use.* In order to ease the supply problem, it is preferable if the equipment can be used over and again without bulky replacement being required.

The electrical stabilization process fits these requirements remarkably well. The equipment used in the field is entirely portable, consisting of rod cathodes and rod or mat anodes, cable, and trailer-mounted DC generators. The electrodes may be used again, although anodes would suffer corrosion and require eventual replacement. A great deal of technical knowledge is not required to operate or set up the equipment in safety.

It is only the time factor which remains as the fly in the electro-osmotic ointment. If a technique could be developed by which sufficient temporary stabilization of a limited area could be achieved instantaneously, or by only a few hours treatment, electro-osmosis could be of widespread practical use in military engineering.

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Field Park Squadrons

By Colonel M. B. Adams, BA, MICE

This article was a talk given at the Engineer-in-Chief's 1962 Study Period. The object was to stimulate thought on how modern civilian trends might be used to help the Royal Engineers. The ideas are the author's and do not necessarily reflect official views.

I want in the short time I have available to put a new and perhaps startling approach to the problem of the Field Park Squadron. My analysis must be on the academic side; it is also very much inspired by the present pace of development. I cannot pretend, therefore, that it can be immediately implemented and in any case very much more detail would have to be worked out. Let me leave you in no doubt, however, that I consider such a solution inevitable and the only variable is the time scale. I hope that I shall both be able to initiate a very controversial discussion and to sow seed for further thought; but I am afraid in the very limited time available I may have to cut short detailed support for my reasoning.

The basis of my argument is the need to increase productivity. Engineer units of almost any type exist in the long run only to do work. The basic problem of survival can hence be summed up, "How can we do more work with less men?" In the outside world the opening up of undeveloped Continents has produced such a major urge to improve standards of living that we are facing a major mechanical (and electrical) revolution that leaves the Industrial Revolution of the nineteenth century standing. Even an organization such as the Conservative party had to admit at their Annual Conference that the building and civil engineering industries were facing a major break-through—what they failed to admit was that our rough and ready construction methods had been overtaken by the precision and speed of mechanical engineering techniques. The national average increase in productivity per man per year in industry is 5 per cent. Over fifteen years this means that a man's output has doubled. Putting it another way, we should need half the number of men to do the same amount of work that we did at end of the war. In fact a Field Squadron's strength is now 214 compared with the figure then of 253. I make the accusation that many of the problems that face the Corps today have risen through a squandering of the Corps' man-power by field units.

It is quite obvious our productivity has not doubled and what are the reasons?

(*a*) We have not mechanized fast enough.

(*b*) We waste our effort teaching skills and techniques that will never be required with tools and equipment that should never be used. Take two quick examples. Firstly, the trade of Painter and Decorator. Can we really afford to let this tradesman take a brush in his hand and use manual methods of signwriting when simple mechanical methods can produce a better answer in a fraction of the time. Secondly, for what conceivable purpose do we teach Bricklayers to make gauged arches? In fact it is highly improbable either trade is even required. We must face the sweeping away of such traditional techniques and their replacement by new ones. The answer may be to have a composite trade (which might be called Building Technician) which could supervise highly mechanized, semi or unskilled labour.

(*c*) There has been no attempt to introduce modern management techniques at the nodal point. Which Field Squadron applies Work Study methods; how many officers in the Corps even know the principles of Work measurement or how to carry out a critical path analysis and allied techniques? Do junior officers ever discuss productivity?

There are other reasons too but as my supporting evidence is more abstract I must omit them.

It is slightly ironical that the National Productivity Year began during the 1962 Engineer-in-Chief's Conference. Can we really face this and say the Corps is leading progress in the traditional way it always has in the past?

Let us get back to the Field Squadron. If we accept its purpose as producing work it must have tools, equipment, plant and stores to do so. To be self-contained to meet all eventualities it would of course be top heavy and, therefore, it must only carry such resources (in the general sense) as have a a high usage factor. If we had adopted scientific management methods we would know what that factor was, but I still think it is obvious that the Field Park Squadron forms the general reserve of such resources. There can only be one basic organization—

Field Park Squadron

Park | Workshops

The Park collects, holds and exchanges resources of all types. The Workshop maintains, repairs and produces them. Let us look at the Park first—it must deal with—

(*a*) General stores, including all types of hardware and construction materials.
(*b*) Plant—C Vehicles, Construction and Electrical and Mechanical equipments.
(*c*) Bridging equipments.
(*d*) Spare parts, not only the Ordnance meaning of the term but the wherewithal to repair all types of engineer equipment.

The following table shows the problems this raises:—

	General stores	Plant	Bridging	Spares
Supply	Local, Ord or Engr	Ord, Engr	Engr	Ord, Engr
Identification	Easy with snags	Easy with snags	Easy with snags	Difficult
Holding	Bulky	Easy	Bulky	Negligible
Maintenance	Some	Major	Variable	No
Transport	GS	Low loaders	Specials	GS

To meet a really highly mechanized system, as I have outlined, I suggest the Park consists of a number of identical Troops who can collect, hold, issue and exchange all resources at a much greater rate than we have ever known.

This produces two problems, namely a management one to plan it and especially to see the Troops who work and operate always have 100 per cent efficient equipments, and a transport problem to move them. I submit in our mechanized age it is completely uneconomical, unflexible and wasteful of resources to have fixed special establishments to look after one type of store—provided the working troops have the right establishment of workers and operators a Park of this type can keep them topped up with their resources. Specialist Plant, Bridging and other troops of this nature must be obsolescent.

Transport is of course the snag—many of the troubles are administrative rather than engineering and can be overcome. I shall come back to possible solutions and standardization of transport later.

The number of Park Troops you require needs management study to investigate based on the formation, theatre, type of warfare, etc.

Turning to the Workshop there are two contradictory tasks to be carried out:—

(*a*) Repair and maintenance.

(*b*) Production.

Each task needs different type of tradesmen, uses different techniques and is difficult to carry out simultaneously in the same organization. First class engineering management can, however, iron out most of the snags.

I have through this talk been mentioning management which in fact is the key to success. No workshop, however small, can work efficiently unless there is constant forward planning to keep it fully loaded. Mechanical and electrical engineering is more susceptible to man-hour analysis than our conventional work. If a formation has a certain amount of equipment it is perfectly easy to calculate what tradesmen, equipment and stores are necessary to repair it though such a task is continuous and never ending. Similar methods can be applied to production work. HQ Engineer Stores Establishment already have much of the basic data available to build up planning sections—if an attempt at establishing such a section is not made the unit will come to a grinding halt as it will be cluttered up by equipment for which there are either no tradesmen, no tools, and no stores or spare parts. A Mechanist and a Corporal Clerk, supervised by an E & M trained Officer, would be a sufficient nucleus on which to start.

Field Park Squadrons do not at the moment generally undertake repair and many officers consider they never should because it is the basic responsibility of REME to do so. I am afraid in the machine age we are approaching it is essential we do so for the following reasons:—

(*a*) We are already completely responsible for much of our vital equipment, including bridging and E & M equipment, and have barely faced up to the problem.

(*b*) Though we are only responsible for Unit Repairs to C vehicles and construction plant, the borderline between such repairs and Field Repairs is undefined and in fact cannot be performed by rigid separate echelons.

(*c*) An engineer organization must have an integral system tying in operators and fitters; it should also be remembered that all Corps tradesmen become Combat Engineers in an emergency.

(*d*) It is impossible to equate the priority for repair of engineer equipment with war-like stores such as weapons, combat vehicles and electronics and the mechanized engineer unit of the future must be self-contained.

Finally it is clearly laid down in *Military Engineering Volume XI* that we must be trained to undertake such work.

I am not going to elaborate on how repairs should be done but there are a few points to raise. The first priority is to make certain that all the equipment is 100 per cent fit for use when the battle commences—this is done by fitters supported by ancillary trades of which the most important is welder. Let us hope that the Corps will get a Fitter RE who is versatile, and that the present illogical jumble of Fitter trades be swept away. Fitter in fact must become Number 2 trade in the Corps after a combination of Combat Engineer /Plant Operator which I will call Combat Mechanical Operator—Combat Engineer is already obsolescent. Secondly, it is not worth opening a Workshop unless you are static for a minimum of twenty-four to forty-eight hours and possibly longer. This means that once the battle begins no static repairs can be done and the Workshop Troop should deploy if necessary into first aid detachments. Such detachments would need lifting gear, welding and cutting equipment, small portable power tools and a portable power supply. Without going into all the pros and cons it also implies that we are wasting our time with equipment such as a Workshop lorry—it would be better to carry the machines we require in an ordinary 10-ton lorry with the machine tools bolted down to channels in the floor so that a better workshop could be set up when conditions stabilize for a short period.

There is no time to talk about production work; it is a more usual task which people are used to. I do, however, want to mention manpower as there is no doubt that workshops must increase in size. Luckily there is a saving factor. In work of a repair nature the more highly skilled tradesmen usually need an assistant and can often sustain from one to three unskilled helpers. The assistant need not be a Sapper, and the unskilled helpers should not be. In production work if the organization is properly managed, and especially if machines of an automatic type can be used, one skilled tradesman might control anything from five to ten semi or unskilled operators who again need not be Sappers. This means that a Workshop Troop of thirty real effectives might in a period of near war or after nuclear devastation become a repair shop of 100 or a production shop of as many as 250.

Up till now I have not mentioned a subsidiary task which will come the way of this unit namely the setting up or repair of damaged utilities and their operation. By utilities I mean water, power, light, POL, heat, cold, etc. I have no time here to deal with the problems involved but the principles are the same. Operation is a task for operating troops and the others must be treated as Workshop tasks on their merits.

How are we dealing with these problems?

(*a*) Increasing the pace of mechanization is a War Office problem and it is not up to me to say any more.

(*b*) A War Office working party is studying the tradesmen problem, and I am convinced the findings will be far reaching.

(*c*) We shall need far more Clerks of Works in the field. The need for Mechanists is obvious as Workshop Foremen, for junior managerial appointments and for highly skilled tradesmen's duties. We will also need Clerk of Works trained in civil engineering. The present Construction Clerk of Works will not be suitable for this, and the new type will be difficult to find as it appears that only about one in six of the present intake could reach the required standard.

(*d*) We will need better trained officers. Officers on the present E & M Courses (on a new syllabus) are being trained for this type of work and hope to be allowed to command such units. Their principle asset is their enthusiasm and it is hoped they will be allowed to show what they can do before this has evaporated in non-productive appointments. To allow untrained amateur officers to command such units would be disastrous and all Sapper officers must have realized by now that E & M is essential to our future.

(*e*) Lastly, and perhaps most important, what are we doing about management? We have lost very valuable ground compared to other Arms and Services. In fact the RSME does teach many management techniques and subjects in an unco-ordinated way, and we are nearly ready to formulate a clear policy which will be put forward for the Engineer-in-Chief's approval.

Where is this leading us? If the pace of development continues, and it shows every sign of accelerating, the number of working men must decrease. Perhaps the largest working unit in the field will become the Field Troop, supported by a Field Park Regiment with a major overall saving in manpower.

Little Nigger Boys

By MATA KACHA

STATISTICS, they say, can prove anything. The other night we held a dinner to celebrate the fortieth anniversary of our first commissions or, perhaps more correctly, a reunion of the survivors of our "Shop" term.

In those days things were still fairly simple; the "Shop" produced Gunners and Sappers only and, having sufficiently defeated the Civil Service Commissioners and duly arrived at Woolwich, you were destined to become one or the other—unless, of course, you misbehaved yourself and became a civilian again. The course ran for two years, divided into four terms, or "Classes"; and, at the end of the first year a notification appeared in Part I Orders headed "Second Class. Bifurcation of", and there we all were neatly bifurcated according to examination results, qualified by an element of choice in the case of those high up in the list who didn't want to be flippin' Sappers and made way for some much lower down who, perhaps, didn't want to be flippin' Gunners.

So, ignoring (as the statisticians do) a few "accidentals", we started as seventy euphemistically styled Gentleman Cadets and became of a sudden thirty-nine potential Gunners and thirty-one putative Sappers. (I name them in order of numerical magnitude, though it will be appreciated that the actual order of merit was the reverse.) The relative demands of the Royal Regiment and the Corps were then so nearly equal that the probability of "getting Sappers" (as the phrase went) was thus of the order of 44 per cent before we even started our training.

Now, we seventy who reached the "Shop" were, in fact, drawn from the top third of the whole list of candidates successful in the Army Entrance Examination of our year. We thus represented a "refined" sample of humanity, from which those of relatively lower average intellectual quality had been pre-eliminated. In analysing the outcome of our course, we should expect the resultant distribution curve to be both narrower and steeper than that characteristic of a less rarified sample; and a little arithmetic will show that, by the end of our first year, the probability of "a good average sixty per-center" among us getting into the first thirty-one (ie, getting Sappers) must have risen mysteriously and of its own accord to something like 77 per cent. Perhaps it is just as well we never had the leisure in those days to engage in calculations of this sort!

We did, however, sometimes wonder where we all might expect to get to in our chosen profession, and what the chances were of getting to the top of our respective arms of the Service. I fancy the limit to which most of us set our sights was the rank of Lieut-Colonel before retirement—with luck. We could, of course, given the necessary data relating to the rank structure of the Army at that time, have made a fairly accurate prediction as a check on this conjecture. At that time the chances were probably rather better in the RE than in the RA, but Mr Hore Belisha and the war between them rather upset any such prognosis. Under the former's new Promotion Code all those of us surviving became simultaneously majors, after only seventeen years' service, shortly after the outbreak of the war. Figure 1 shows how, in the event, this and the explosion of 1939–45 distorted the probability curve an average of two steps forward on the rank-scale (the time-scale becomes meaningless at this point), and some 40 per cent of us made the rank of Colonel in nearly equal proportions of RA and RE.

On the whole, the Gunners seem to have managed rather better than the Sappers, due, probably, to the considerable accretion of Brigade and Divisional Commanders required in the enormously inflated Anti-Aircraft Branch of the Artillery. Surprisingly, not one of us found it necessary to draw the Field-Marshal's baton from the depths of his haversack.

Fig 2 gives the average survival probability curve scaled to our original aggregate strength of 70. Against this control we see plotted the actual survival figures expressed as percentages of the total. The time-scale is here once more applicable and we see that the war seems to have treated the Sappers lightly; and indeed, up to the present time we have, in this respect at least, behaved almost normally. The Gunners' war was apparently a less lucky one, but those who survived seem to have gained something in endurance, so that they, too, at the present state of play show little below normal wastage. About 50 per cent of us are still going strong along the primrose path.

Now we come back to the dinner; at the conclusion of which it was unanimously resolved to hold further reunions at ten-year intervals into the future. Fig 3 shows that rather less than 50 per cent of those living in fact attended on this first occasion, in approximately equal proportions RA and RE. Assuming the proportion of "availables" dining to remain constant, the forecast of attendance for future reunions takes the shape indicated by the three curves. For the benefit of our Secretary we can predict that fifteen of us should gather for the next function; and that, in twenty years' time, a table for four at a good restaurant may suffice. It looks as if I dine alone in 1993.

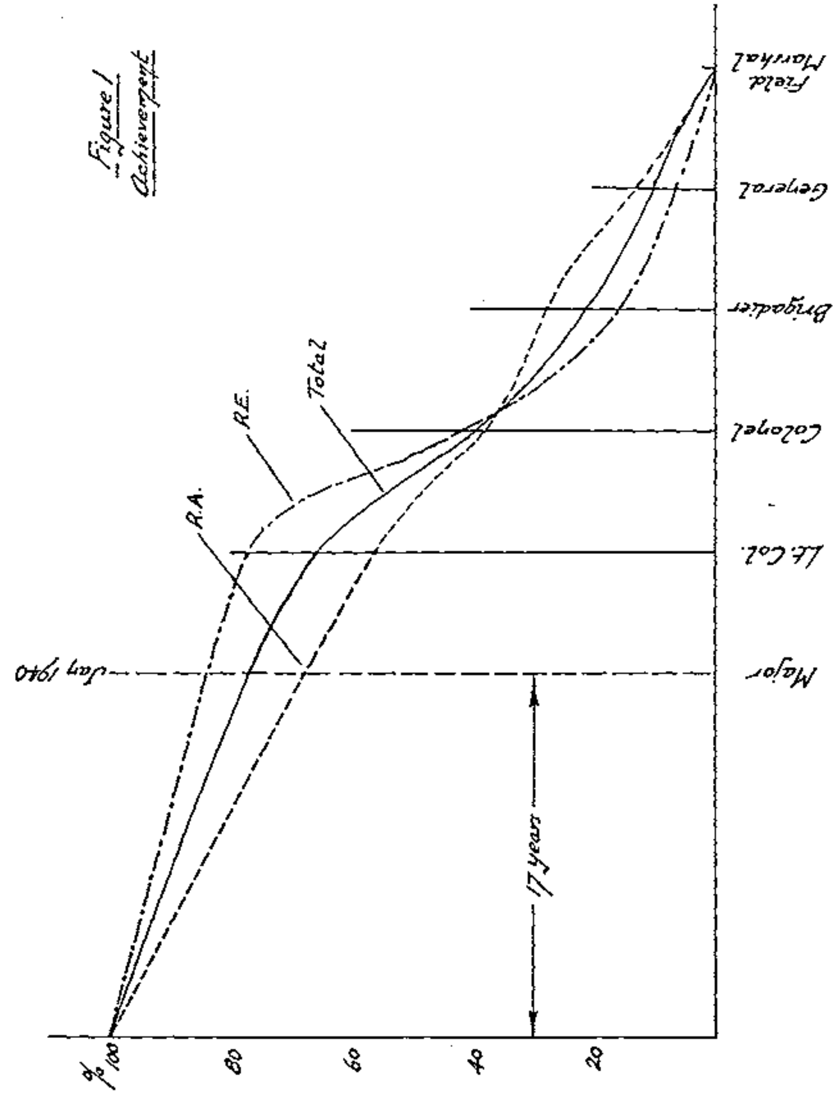

Figure 1
Achievement

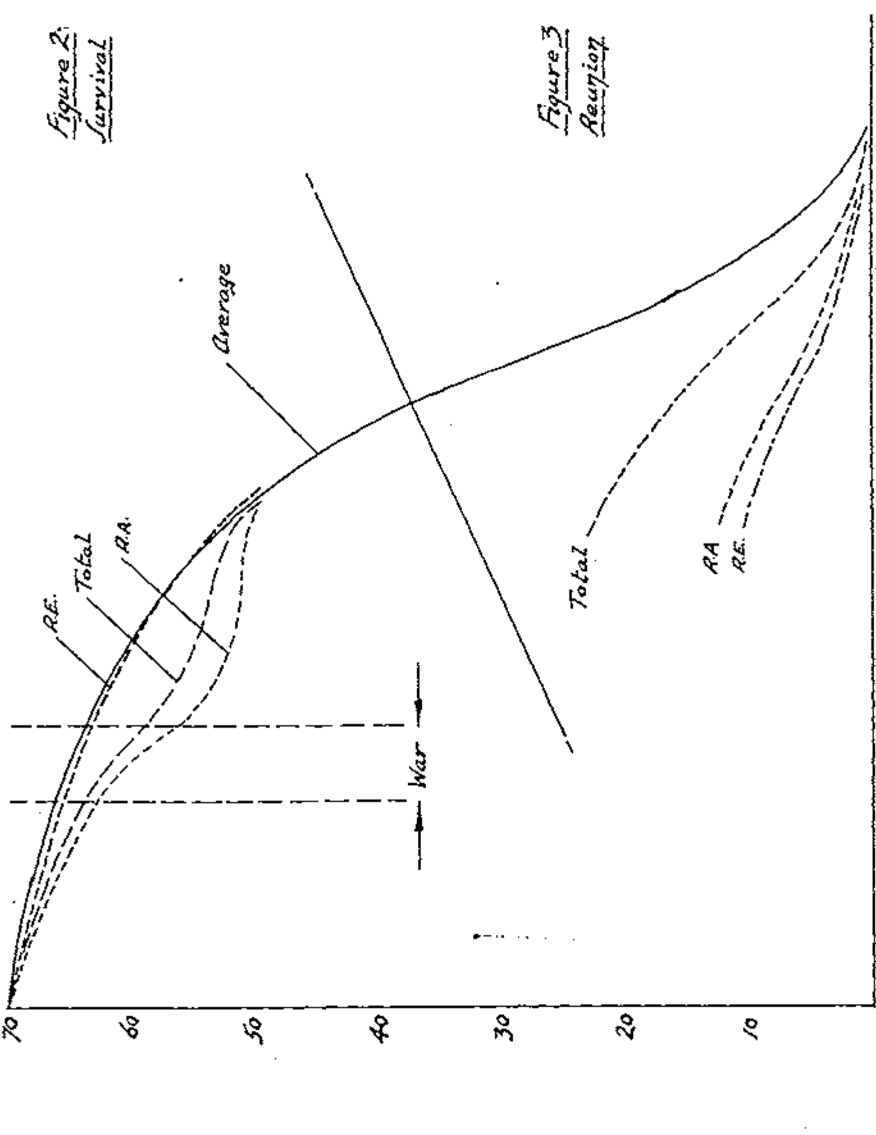
Figure 2
Survival
Figure 3
Reunion
Average
R.E.
Total
R.A.
War
Total
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R.E.
70
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50
40
30
20
10
Years
10
20
30
40
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60
70

Fresh Water in the North Libyan Desert

By Major F. Moseley, MA, BSc, PhD, FGS, RE (AER), Geologists Pool

During the summer of 1962 I was called upon, as a member of the AER Pool of Geologists, to advise upon the location of fresh water for exercise "Egg-flip". The exercise was to be based on the Bomba region of Cyrenaica, relatively unknown country geologically, and therefore of considerable interest to me. Subsequently, after an extremely profitable exercise, this article suggested itself for two reasons, firstly to outline principles of water supply applicable to much of the North African coast, principles which are readily comprehended, and should enable any engineer officer to make some assessment of water prospects in these areas, and secondly, to draw attention to one aspect of the work of the Geologists Pool.

Having been given only a few days notice before leaving for Bomba there was little possibility for serious preparation, and to begin with I had a rather naïve idea that there was to be some form of dependence of the troops on the efforts of Captain D. B. Bell and his well borers and myself. Our initial visions of dehydrated soldiers staggering across a waterless desert were quickly revised on finding records of the Timimi water point (developed by the 8th Army in the first instance), which was still in existence and more than adequate for all the needs of the exercise (see below). Of course it should have been obvious all along that the success of this short exercise could not afford to depend on the simultaneous finding and development of water supplies.

Although the short notice somewhat limited initial preparation, it so happened that all the war time records and papers of Professor (then Major) Shotton were readily available, but there was insufficient time to obtain the Italian literature. This experience perhaps stresses how important it is that the Army should have at its disposal a method of abstracting and storing information so that it is readily available. Such a method was described in the June 1962, *RE Journal*, page 185, by Captain P. H. T. Beckett.

During my stay at Bomba I was able to reconnoitre about 200 square miles, partly by Land Rover, and partly on foot (Fig 1), and the following account is based essentially upon the results of this survey.

The hinterland of Bomba is an eastern extension of the Gebel Akhdar (Green Mountain). It is stony shrub desert, with an annual rainfall of between 5 and 10 in, and an appreciable population of semi-nomads, who keep herds of camels, goats and sheep, and, near the coast, a few horses and cattle (Evans-Pritchard, 1949, McBurney and Hey, 1955). To the north-west, between Derna and Barce, the rainfall increases with resulting greater fertility, and to the south it decreases rapidly until 50 miles south of Bomba it is negligible.

The topography is extremely simple. The low plateau forming the eastern part of the Gebel Akhdar, falls gently towards the Gulf of Bomba. Inland this plateau is cut into by a number of steep sided flat bottomed wadis, typically about 50 ft deep, but the channels become ill-defined towards the coast and by the time they cross the main road they are relatively insignificant features. The most important of these wadis are, from south to north, Wadi Timimi, Wadi Maallegh (one of the most important wadis in Cyrenaica), Wadi Hanaui, the wadi complex at Um Errezem and Wadi Genan.

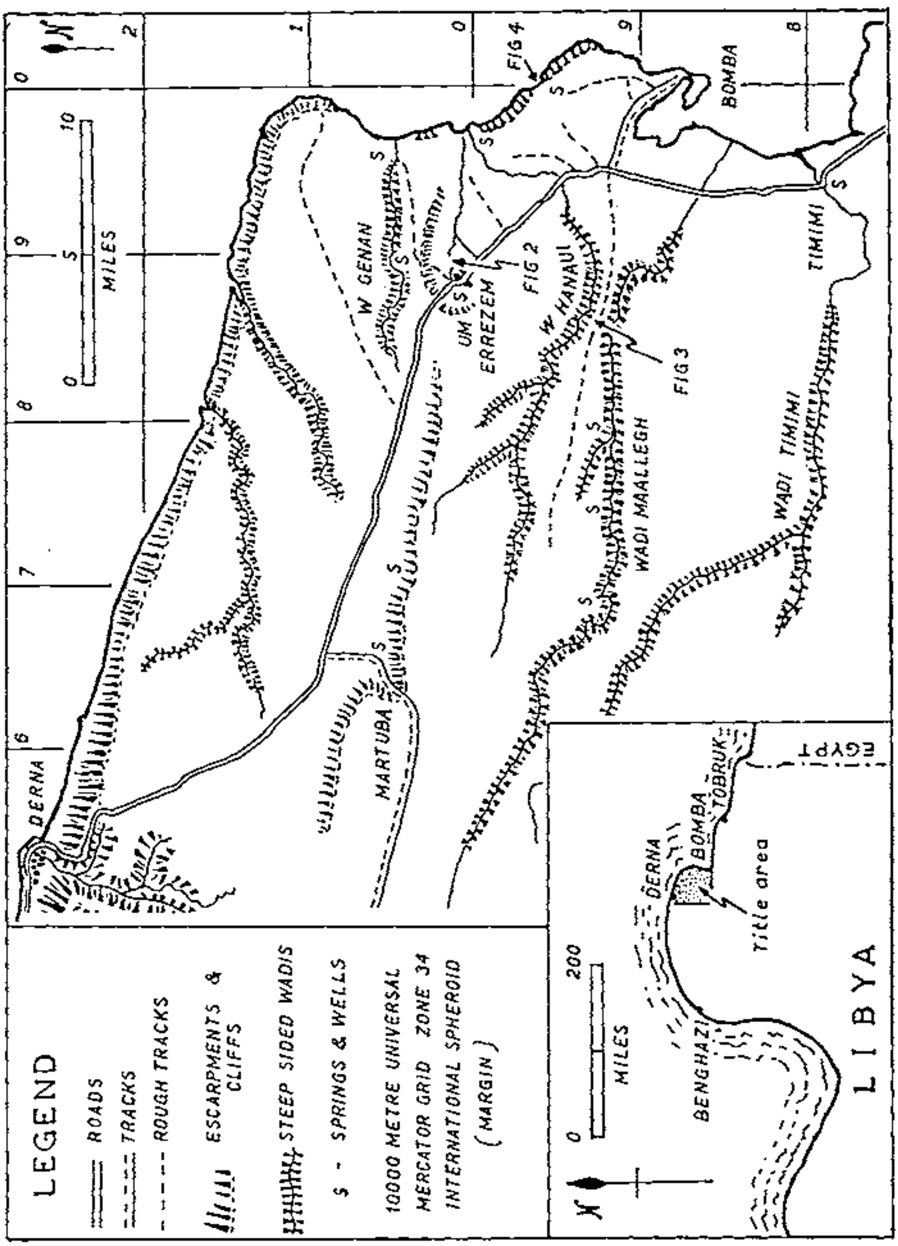

Fig 1. Map of the Bomba area, Libya.

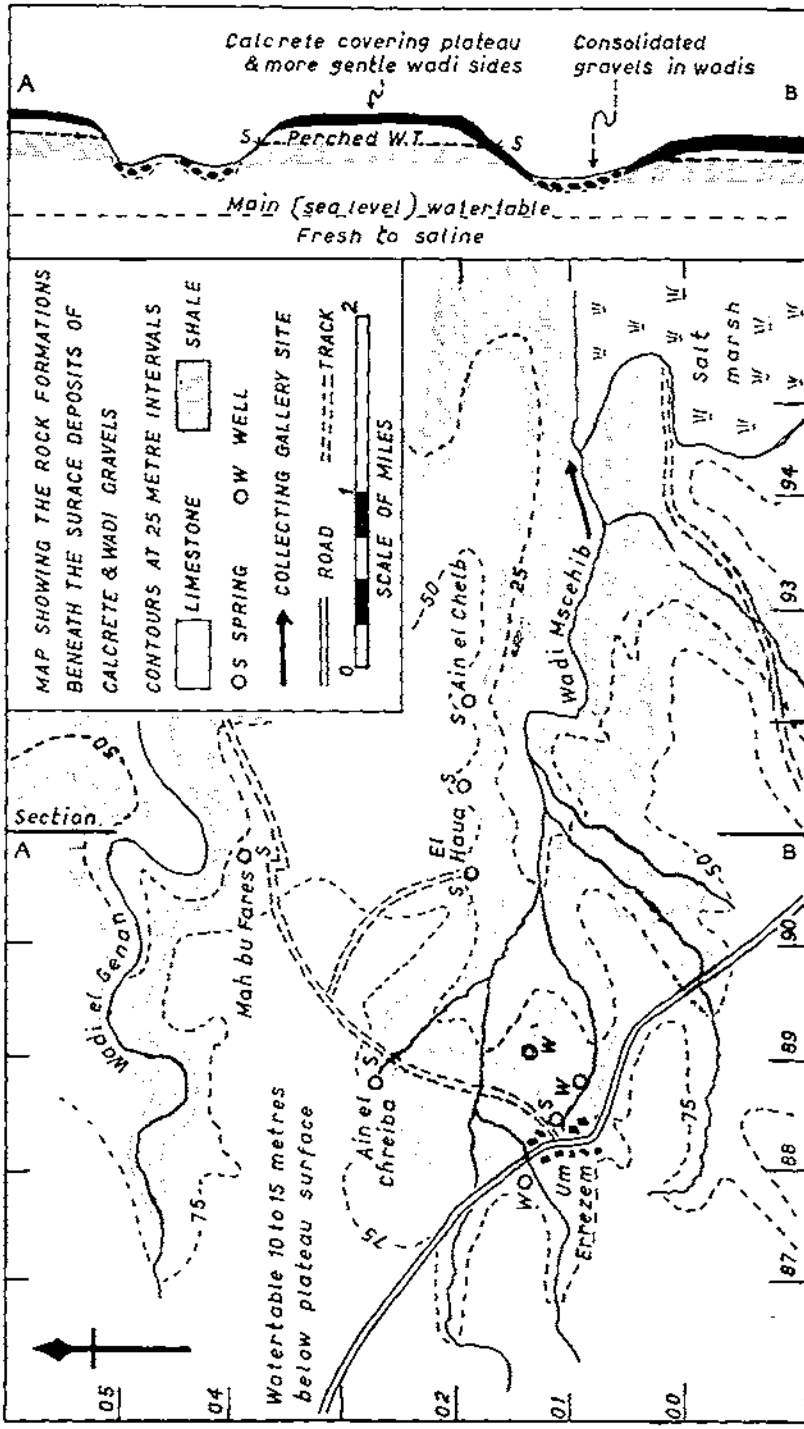

Fig 2. Geology of the area around Um Errezem.

Practically the whole region is underlain by limestones of Tertiary (Miocene) age, well exposed along the incised wadi courses of the inland plateau, but elsewhere concealed from view beneath a thin hard crust of surface limestone (calcrete), a deposit of recent origin. Along the coast the most important deposits are cemented (fossil) sand dunes, which form low cliffs, present-day dunes, and areas of salt marsh (plastic clay). These deposits, together with wadi deposits will be referred to in turn, and their bearing on water supply will be discussed.

Water in the Tertiary (Miocene) Limestone

The two dominant types of rock are a relatively hard limestone made of broken shells and a much softer chalky limestone. Both are extremely pervious and are cut through by numerous open fissures or joints capable of freely transmitting water. Interleaved with these rocks there are occasional thin beds of nearly horizontal impervious shale which halt the downward passage of water. Shotton (1944 and 1946) observed that from the Alamein area westwards the water table in these limestones is related either to the impervious layers (perched water tables), or to sea level (the main water table).

(*a*) *Perched water tables.* Water tables at various heights above sea level are common in the Derna area, but become rare to the south and east with the diminished rainfall. The most important perched water tables in this latter area (Fig 1) are near Martuba and Um Errezem, where there are irrigated areas with date palm, prickly pear, fig, etc. Fig 2 represents the Um Errezem area in more detail. Here the plateau-forming limestones are underlain by about twenty feet of shale, which outcrops on the wadi sides and throws out a number of springs. These rocks can be inspected in one or two localities only, because of the concealing crust of surface limestone (calcrete) on the pleateau and wadi sides, and the lime cemented (calcreted) gravels on the wadi floors. The springs are at Um Errezem (the largest with a flow probably in excess of 2,000 gal per hr and a salinity of 150 to 220 parts per 100,000—note that these estimates are made for the beginning of July), at Ain el Chreiba, about 600 to 1,000 gal per hr with a salinity of 70 parts per 100,000, at Mah bu Fares, not estimated but smaller than the above and at el Haua and Ain el Chelb the smallest of these springs. It would be an easy matter to tap this water table by boring on the plateau north-west of Um Errezem.

South of Um Errezem there is no direct evidence for perched water tables in the form of springs, although, in the Hanaui-Maallegh region there are thick shale formations at two levels (Fig 3), and in combination with suitable structures there is no doubt that important water supplies would be available. The most favourable type of structure is the shallow basin such as that at Fuka, further east (Shotton, 1944).

(*b*) *The main* (*sea level*) *water table.* Numerous boreholes were put down by the Army between Alamein and Gazala during the Middle East Campaigns and in the great majority of cases a water table was encountered just above sea level. Although the source of this water is direct rainfall it is usually too saline for drinking, partly due to the presence of some salt in the limestones and partly to the scanty rainfall (Shotton, 1946, p 3). However, pockets of fresh water were located and exploited in a number of areas, typical yields being between 100 and 700 gal per hr. These pockets of water were considered by Shotton to be held in fissures (master joints) which rarely intersect. This explained the rapid horizontal variation in the yield and quality of the water.

The region west of Bomba resembles that further east, and there will be a main water table close to sea level, but I believe the fresh water prospects are more favourable for the following reasons. Firstly, the western hinterland of Bomba receives a greater rainfall than Marmarica and Egypt. Secondly, there are several large wadis draining eastwards from the better watered regions of the Gebel Akhdar which bring large quantities of water towards the coast in winter (Fig 1). Thirdly, there is a slight regional dip of the limestones towards the east favouring underground water movement towards the coast.

(c) *Future development of water supply in the limestones.* The perched water table of Um Errezem, is an obvious supply which could be tapped by boring to the north and west of the oasis (Fig 2). Further to the west and to the south-west, between Martuba and Wadi Maallegh (Figs 1 and 3) there are two thick shales in the rock succession, and I believe further survey would reveal perched water-bearing structures so far untapped. Such a survey could form an interesting part of some future exercise and should be concentrated on the steeply incised wadis, where the important combination of impervious shale and structure can be seen and plotted.

Geophysical methods, particularly those making use of resistivity (Tellohm) would be valuable in following structures across the unexposed plateau and in locating isolated patches of underground water.

Unlike the perched water tables, the main (sea level) water table is to be expected throughout the region, and would be best explored within a few miles of the coast, in order to keep the depths of boreholes within reasonable limits. The difficulty here is in predicting salinity and yield.

The actual drilling is easy once the hard calcrete crust has been penetrated, but when indenting for equipment one must remember that water obtained will be in small quantity, and it is essential that the pumps used should, if necessary, be capable of dealing with amounts of less than 100 gal per hr. The salinity is always an important consideration in deserts, and field salinity testing kits (Shotton, 1945) must be in the possession of surveyors and well boring units.

Water in the Wadi Gravels

The principal wadis are floored by a thin skin of loose gravels beneath which are older lime cemented (calcreted) gravels. In favourable situations the wadi gravels will yield considerable supplies of water, the important criteria being as follows, (i) the proximity of sea level and the main (Miocene Limestone) water table; (ii) impervious strata in the limestones; (iii) the thickness of the modern gravels and the cemented gravels; (iv) the catchment areas of the wadis. The water in practically all cases should be obtained by constructing collecting galleries, essentially tunnels or covered trenches cut down along the wadi floor to one or two feet below the water table, the water being collected at the "downstream" end. In wadi situations collecting galleries (sometimes wrongly referred to as aqueducts) give far greater yields than boreholes, since they are capable of skimming off the thin layer of sweet water which all too often rests on salt water. The more important wadis are as follows.

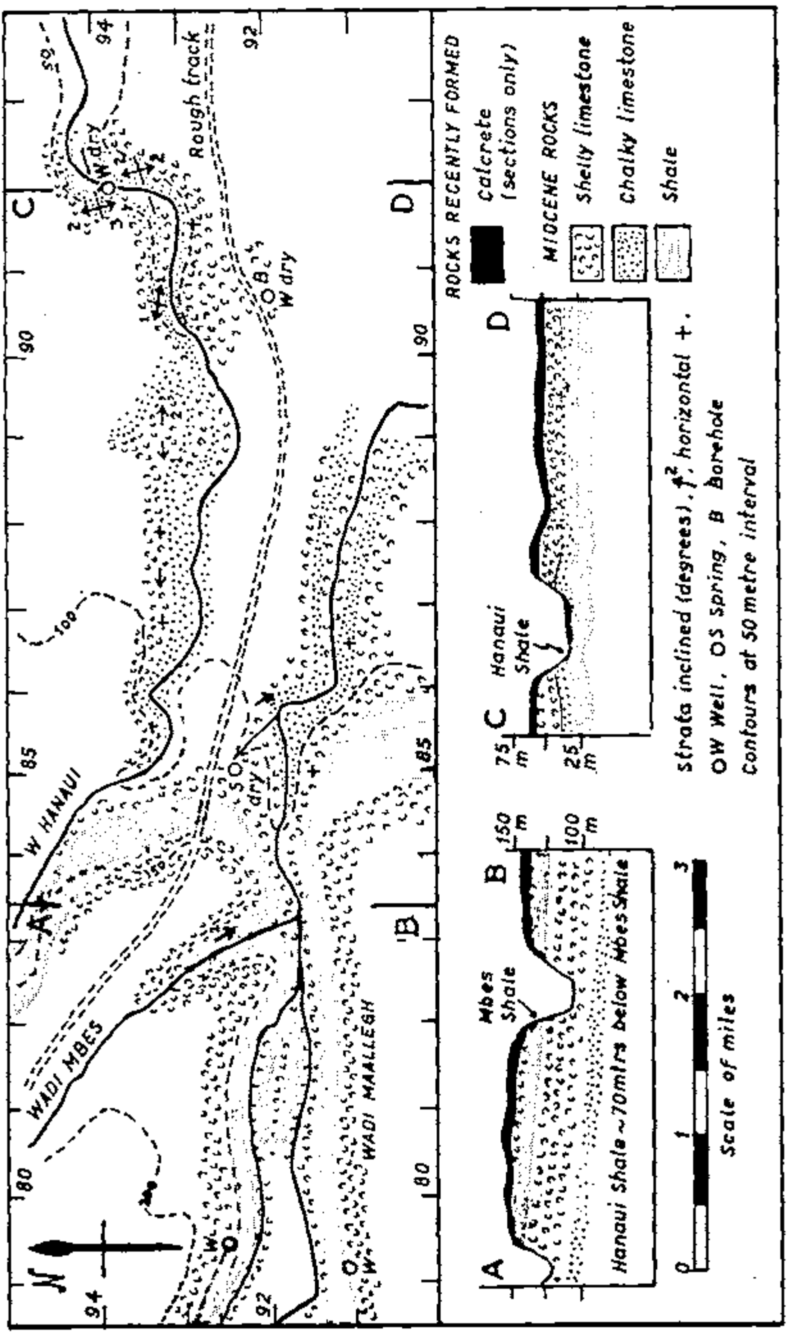

Fig 3. Geology of the middle reaches of Wadis Maallegh and Hanaui.

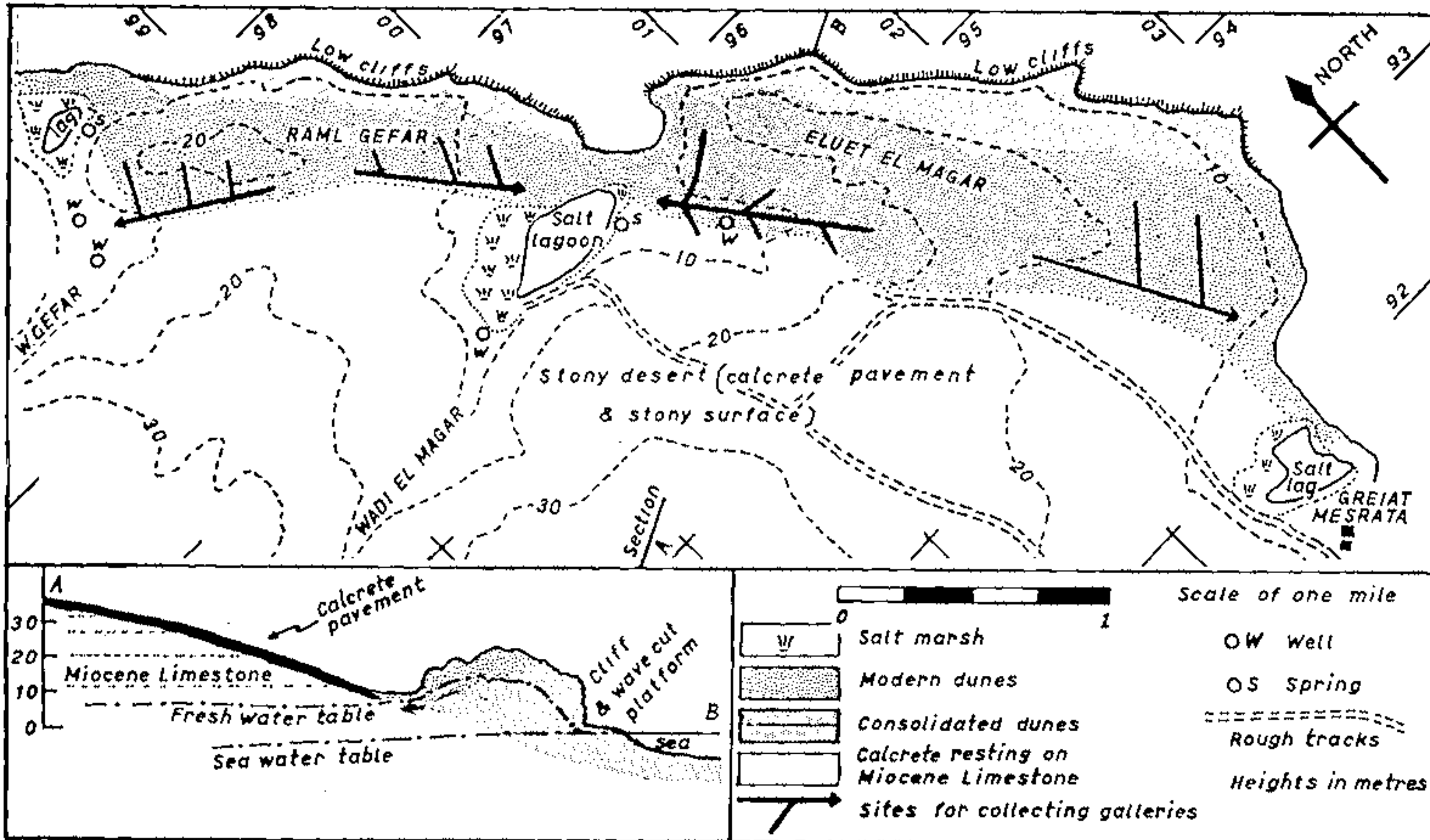

Fig 4. Map of the dune area north of Bomba.

(*a*) *Wadi Timimi.* Adjacent to the village of Timimi (9479) water is found at the base of partly cemented wadi gravels about five feet below the wadi floor (July). Timimi is only a few feet above sea level and it is probable that the water table in the wadi is to some extent held up and supplied by the main water table in the Miocene Limestones. During the last war the Army constructed a collecting gallery here, the maximum yield being about 650 gal per hr (70 tons per day) with a salinity of 160 (per 100,000) (Addison and Shotton, 1946, p 11). At the present time the water is lifted by a motor pump to a tower above the village. Care should be exercised in the use of this water since there will be some contamination from the village.

(*b*) *Wadi Maallegh.* This is one of the largest drainage channels in Cyrenaica originating in the well watered Gebel Akhdar and coming down to the Gulf of Bomba 5 miles north of Timimi (Fig 1). Although there is an apparent absence of water along the lower reaches of this wadi the situation is analogous to Timimi, and I believe that a collecting gallery constructed east of the main road but west of the salt marsh would give a supply. Excavation of a trench along this wadi would be more difficult than at Timimi since the older gravels are firmly cemented into a hard rock. Fissures in this rock parallel to the wadi direction will permit ready flow of water.

(*c*) *Wadi complex of Um Errezem.* Water draining from the perched Miocene Limestone water table of Um Errezem finds its way into the gravels of the wadi complex. This water is held in cemented (calcreted) gravels where they rest on the shale (Fig 2) and is at a depth of 5 ft near the main road (well at 881012) and at a depth of 15 ft, half a mile downwadi to the east (large well with irrigated area at 890015) (July positions). In my opinion there is also water in or beneath these wadi deposits at all points between Um Errezem and the Salt Marsh (Mneghir Scehuan, 9501), and a collecting gallery constructed along the lower reaches of Wadi Msceihib (943007) where the water table will be nearest to the surface, should give a good supply. The principle is the same as for the Timimi supply. Access to this point is by way of a rough track which leaves the main road at map reference 910986.

Water in Sand Dunes

Along parts of the North African coast both cemented (fossil) dunes and modern dunes have yielded supplies of fresh water. In the Bomba region the fossil dunes extend well below sea level and are hard enough to give a well defined wave cut platform backed by low cliffs. They are over-ridden by modern dunes which form a series of hummocky ridges rising to between thirty and sixty feet above sea level (Fig 4). The water which is derived from winter rains is preserved in the porous dune sand and sometimes (but by no means always) forms a cushion of fresh water on top of salt water, which can be tapped by means of collecting galleries. It is important that only the top layer (two or three feet) of sweet water is drawn off, since too much draw-down quickly brings in salt water from below (Addison and Shotton, 1946, p 3).

North of Bomba several of these dune areas could be developed as above to give fair supplies of fresh water. As an example I will describe the hydrology of the Eluet el Magar dunes 6 miles north of Bomba. These dunes are accessible from Bomba by means of a track (Fig 4). At the northern end a fresh water spring emerges at the junction between dune and limestone (calcrete), immediately above a salt lagoon (000957). The July flow is about

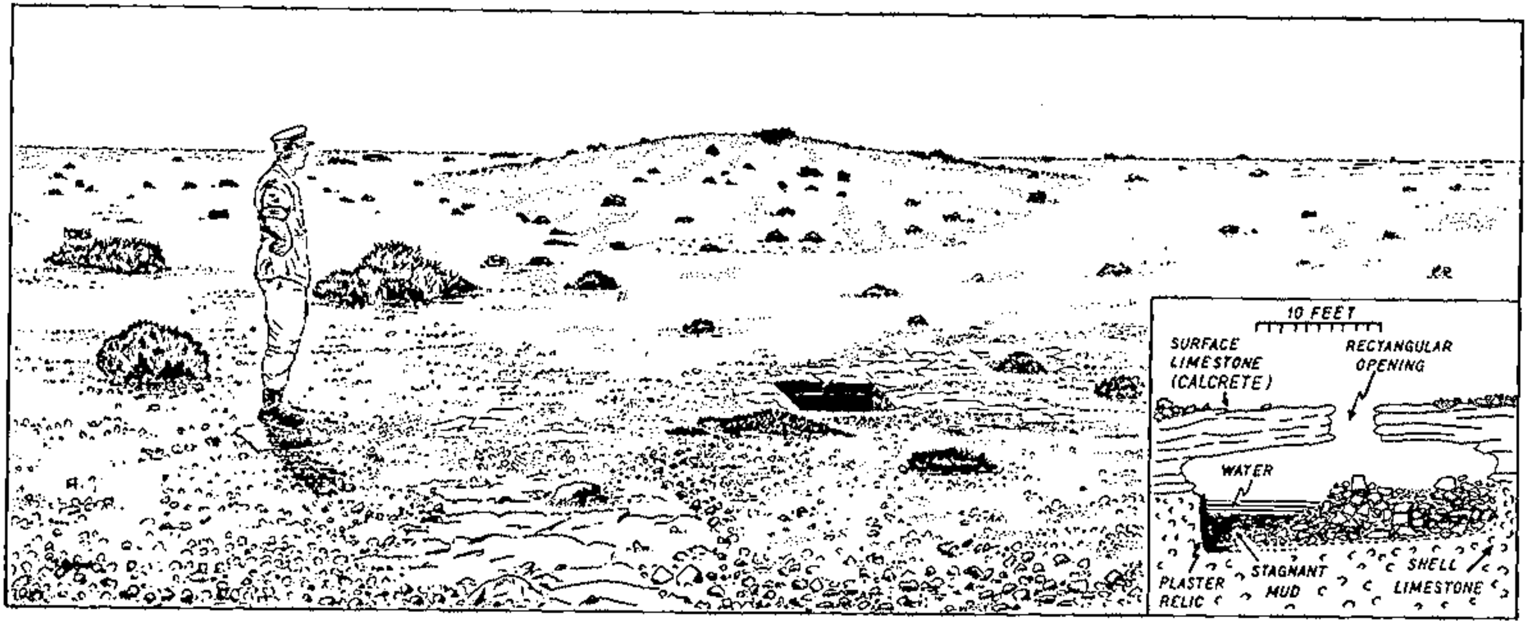

Fig 5. Sketch (from a photograph) showing the entrance to a cistern and its spoil heap. The section shows a typical cistern.

200 gal per hr and the salinity 180 per 100,000 (the spring is not more than a foot above the water level of the salt lagoon and this may affect salinity). Quarter of a mile SSE of this spring, and about twenty feet higher, there is a small cultivated area and a well with water 5 ft below the surface. It is obvious that the water table is only a few feet below the surface between these two localities, and a collecting gallery constructed with this orientation, near to the edge of the dunes (005952) should give a fair supply of fresh water. This could be increased by the construction of branch galleries into the dunes as shown (Fig 4).

The dune area of Raml Gefar farther north (9997) has almost identical characteristics to those described above, including a fresh water spring at the north end (980980), but is less accessible to motor transport.

Other Water Sources—Cisterns

In this region there is a large number of cisterns attributed to the Romans which can be useful for small emergency water supplies. They are underground chambers typically 10 ft deep and 20 to 30 ft in diameter, and were originally lined with plaster (still preserved in a few cases). They were usually sited in shallow depressions on the plateau surface so as to collect the run off during winter rains and store it and protect it from summer evaporation. They can be recognized from a distance by the shallow pyramids of the spoil heaps standing up above the near horizontal desert surface (Fig 5). As would be expected most cisterns are in a state of disrepair (Professor Shotton estimates that farther east one in four is likely to contain some water), and of those we examined near Bomba the majority had collapsed and others were either completely dry or only had a small pool in the bottom. An example of a cistern conveniently placed which still contains a fair quantity of water is at Bomba point (002862) (there are two cisterns here (one dry), both of which have been built up recently with "well parapets").

In the foregoing account I have tried to show how a reconnaissance survey for water can be conducted in a particular type of desert terrain. My experiences during this survey added to those of Captain Bell and his well borers, prompts me to suggest that on some future exercise of a similar type, there should be a more serious attempt to survey and develop both borehole and collecting gallery water supplies *for use during the exercise.* Success would not only give satisfaction to the units employed, but could be of permanent value to native populations, whilst quite obviously without such purpose an exercise, however well conducted in other respects, will be shrouded by the artificiality of untried theory.

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Some Aspects of Ship-to-Shore Movement

By Colonel R. C. Gabriel

Introduction

Discharging a cargo ship by lighter is obviously not the quickest way, yet there are many occasions in peace as well as in war when such procedure must be carried out, for instance because of a lack of quays, insufficient depth of water alongside or at the bar of a river, because the quays cannot bear the load, or because the system of clearance of the cargo inland is inadequate for one reason or another. A port may just be too congested or too vulnerable in war, so again lighters must be resorted to. There may not even be a port conveniently sited at all and an over-the-beach operation must then be carried out.

Aim

The aim of this paper is to study the whole ship-to-shore movement problem including the lighterage question and review the various types of lighter that might be available for military use.

The Lighterage Task

First, some explanation of the term "lighterage port" is necessary. This is a port where ocean-going ships cannot berth alongside, but must lie at anchor, possibly several miles from the port where cargoes and even passengers are brought ashore by lighters.

Aden is probably one of the best known examples, certainly as far as ocean-going shipping is concerned, and one nearer home is Limassol. Some ports like Singapore have alongside berths and roadsteads too, and there are many where only a proportion of the cargo goes straight from ship to quay or vice versa. So that cargo can be delivered cheaply and easily to other riverside or coastal destinations, or transferred between ships engaged on different services, ships often discharge into or load from lighters while they are berthed alongside a wharf, e.g. in the Port of London; and working both sides of a ship simultaneously enables the whole cargo handling operation to be completed in the minimum time.

This is where a lighter becomes a barge, or one should say reverts to being a barge, for this term is the generic one and only when a barge, be it powered or dumb, is employed in the ship-to-shore role does it become a lighter.

Depending on its purpose, many shapes and sizes are possible but, except in certain NW European and United States ports linked to large rivers or canal systems, their capacity rarely exceeds 200 tons and is often only about 50 tons. Sampans are well known in SE Asian and Chinese ports, just as dhows and feluccas are in Arabia, but few of these can carry heavy military loads and hardly any a motor vehicle, much less a really heavy lorry or tank.

Now, in the modern concept of war, these are just the things that we are unable to bring in by air, at least during the next decade or so. Admittedly there may be some suitable craft owned by a particular firm in the area, and of course, the big oil companies leap to mind, but even they do not usually possess lighters of the right size or in sufficient quantity. In fact they themselves sometimes have to hire craft from the Army to transport heavy earth-moving equipment and machinery to an island or other unlikely destination.

Thus there is a clear need for vehicle-carrying military lighters even at a civil lighterage port, unless all the transport is being landed direct to quay or being brought from a forward base by landing ships or craft. Even for normal supplies and military stores and equipment the native craft are not particularly suitable, being slow and awkward to unload and constructed with a laden draught of 4 or 5 ft, no ramp or bow door, no facilities for fork-lift vehicles and usually quite difficult access by crane hook. Thus for normal use also some form of imported lighter may be desirable.

But these lighters are exceedingly heavy and cannot easily be transported to the scene of operations, except by special heavy-lift ship. Furthermore, unless they have an amphibious characteristic, they usually introduce an extra link in the handling chain. In peacetime and in certain countries where native labour is cheap and plentiful, this may not matter seriously, but in war or when some crisis threatens, the extra labour required and the loss of time involved would certainly be unpopular with the planning staffs and possibly quite unacceptable. Moreover, ships themselves, vulnerable to air bombardment or underwater attack, should be cleared under war conditions in hours rather than days,[1] possibly without even actually anchoring. Present equipment and techniques, however, have not yet advanced enough to permit such a quick discharge as a normal procedure, especially if the ship is anchored offshore.

Special Container and Roll-on Roll-off Ships

In the last five or six years however there have been some most interesting developments in ship design with the object of speeding up cargo handling to a maximum both in the military and commercial fields. On the civil side, container ships sometimes referred to as "lift-on lift-off ships" have been put into service which have created history by achieving fantastic handling figures, though admittedly always under alongside conditions. American shipping offers a number of examples; the Pan-Atlantic Steamship Corporation started express "Sea–Land" services from New York to Miami, Houston and other southern ports, with so-called "trailer-ships", such as the *Gateway City*. These are former C2 ships modified to carry 226 large 35 ft long containers which are really trailer bodies with a maximum gross weight of 50,000 lb. Each ship is fitted with deck-mounted gantry cranes, with an 18 ft jib extension, which are all that she needs to load or discharge herself

[1] An ocean-going freighter will need from three to seven days under favourable conditions to discharge a full cargo to lighters in an anchorage.

Photo 1. Vehicles being driven through the stern gate of the American MSTS roll-on roll-off ship *Comet* on to the Beach Discharge Lighter *John U. D. Page* for ferrying to the shore and eventual discharge there over the BDL's bow ramp

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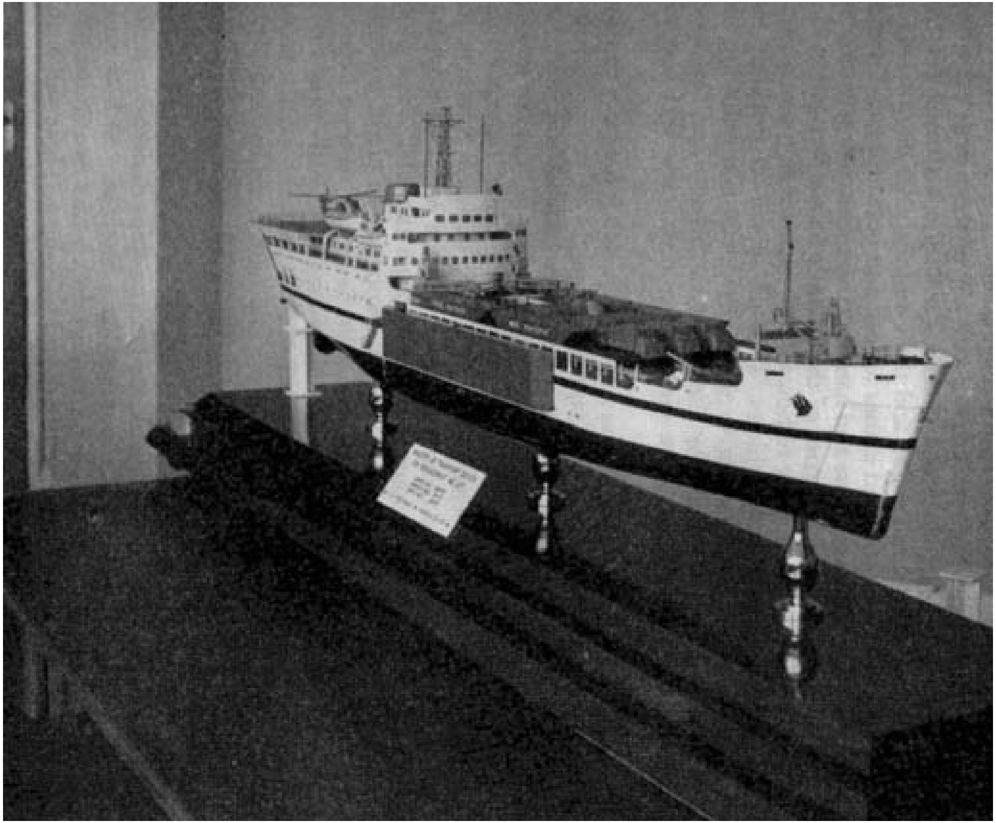
alongside the quay; 4,000 tons can actually be loaded or discharged in only 8 hours! These services continue to grow and, with more ships, San Juan (Puerto Rico) has been added to the list of ports. More recently bigger ships have been converted, e.g. the *Elizabethport,* once a T-2 tanker. She now carries 474 "Sea-land" containers and can discharge them all and take on a fresh load in 48 hours. Taking 20 tons as the average weight of each, this gives a handling figure of nearly 19,000 tons in that period! There are others that steam further afield such as the Grace Lines' "Seatainer" ships, *Santa Eliana* and *Santa Leonor*, employed on the run between Baltimore/New York and the Gulf of Maracaibo. These also have their own special gantry gear and can carry nearly 500 containers of the size already mentioned. An Australian example is the Melbourne–Launceston container ferry *William Holyman*, equipped with four 10/14 ton electric cranes.

We in Britain have nothing to compare with any of these large container ships but there are numerous small vessels specially constructed for the container traffic to Northern Ireland and the Continent. All these however rely on quay or other shore based cranes to load and unload them. Though capable of carrying some containers and handling them with their own electric crane, the fine modern vehicle ferries of the Atlantic Steam Navigation Co, such as the *Cerdic Ferry*, are really roll-on roll-off ships for all types, including the biggest, of commercial vehicles. The roll-on roll-off principle has been preferred to the container one in the military field and following the impetus given to this sort of idea by the American Military Sea Transport Service with their *Comet* in 1958, we are using it in our new WD Logistic Ships.

The *Comet* is a deep-draught roll-on roll-off ship, 500 ft long and capable of carrying 378 laden vehicles or an equivalent weight of stores. She discharges through side or stern ports or in the conventional way with her derricks. Recognizing the one "deficiency" of this ship, ie, that she needs a quay to permit rapid discharge of vehicles, the US Army Transportation Corps developed a Beach Discharge Lighter (BDL) designed to accept the roll-on roll-off cargo from the *Comet* and ferry it to the beach for discharge over its bow ramp. In an accompanying photograph the BDL *John U. D. Page* is shown connected to the *Comet*. By the appropriate use of pontoons and short bridge spans, transfers between the *Comet* and various types of landing craft can be carried out in sheltered waters. The BDL must surely be one of the largest lighters in the world and certainly the most sophisticated, being 350 ft long and fitted with every known modern mechanical and electronic device. Furthermore this lighter can cross the Atlantic under its own power!

Unlike the *Comet,* our WD Logistic Ships, the first of which is now approaching completion on Clydebank, are landing ships designed to beach. The Landing Ship Logistic (LSL) however has a finely-shaped bow and a good turn of speed. She can carry pontoons on deck under two 20 ton SWL electric cranes or assembled into "strings" and side-slung. These will enable "the wet gap" to be bridged or at the worst "ferried", for, although the vessel is a landing ship, the beach gradient may well be such that a "dryshod" or even a "splash landing" is impossible. Nevertheless she will be a wonderful ship, capable of carrying not only a good quantity of vehicles and stores but also up to 350 troops. Besides being able to transport helicopters as cargo she will have a helicopter platform right aft. Furthermore, her lower deck,



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as in an LST, will be able to take very heavy vehicles, engineer equipment or tanks, while under certain conditions she could doubtless if necessary be used as a sort of "luxury lighter". The use of landing ships, however, in such a role would be exceptional; an LST was however used as a "vehicle jetty" in the Musketeer operation at Port Said when MT was discharged from a ship, moored stern on to the Abbas Quay, to its upper deck, whence it was driven down the ramp and out through the bow doors on to the quayside.

Landing Craft

Landing craft are often used as lighters, particularly LCMs and LCUs, both of which types are used in the build-up phase of amphibious assault operations. Apart from a few British LCMs, nearly all these are American, mainly in the US Navy, but also in the US Army Transportation Corps. The popular size is the LCM (6) which weighs 28 tons light and so can be transported by most ships and swung out with ease. The bigger American LCM (8) weighing just over 60 tons is normally carried over long distances inside a Landing Ship Dock (LSD). Very few American ships can lift it with their own gear. The new British LCM is even bigger and heavier and is intended for carriage within the new Landing Ship Assault. Some British ships could lift it using their own gear but not many.

The LCU is a very much bigger craft and normally can only be transported within a deck type ship; the "501 class" weighs 150 tons but with its enormous capacity of 130 tons or about seven vehicles it is a most useful ramped lighter. It is like a cross between a "Z" Craft and an LCT, and in America it has long since replaced the LCT. A later class of LCU is slightly bigger.

We still have the LCT (8), which, like other landing craft, is not primarily a lighter. In fact it is a very awkward one in many respects, since, due to its width (38 ft), ships derricks cannot usually plumb all parts of its 25 ft wide deck. In the case of heavy and awkward equipment this may necessitate the LCT having to cast off and turn completely round. The length of the vessel moreover is such that, unless two adjacent holds on the ship are being worked to it, lighterage space alongside may be wasted. However, its beaching capability and bow door can be most useful in the case of many cargoes, particularly vehicular ones. The LCT is seagoing in reasonable weather but has a speed of only 9 knots and a somewhat limited range.

Other Military Craft

Though obsolescent, the "Z" Craft has proved a wonderful powered lighter throughout the last twenty years. It is not a sea-going vessel and was intended for inland waterways and harbours. In good weather it can make coastal passages, but its size and weight preclude transportation by lifting over long distances. It is true that there are a few ships in the world that could lift a "Z" Craft, but unfortunately not one is British and in any case it is unlikely that any "Z" Craft today could survive such a lifting operation. It is, of course, possible to tow a "Z" halfway round the world by making special arrangements, eg, stiffening the deck, but in general, to be of any use in an operation, "Z" Craft must be prepositioned or close at hand. With its 175 ton capacity and shallow bow draft, a "Z" Craft is a most useful lighter that can carry two or three tanks or up to about a dozen vehicles, depending on their size, and a load of fresh water under the deck. As many as about 200 troops can be carried over short distances and "Z" Craft were used for carrying thousands of troops between ship and shore at Suez and later at Port Said during and after the last war. Each had a crew of nine who lived in board. There is not space here to describe how dozens of these craft were assembled at Ismailia from parts prefabricated in India, how some were used as gunboats off the Lebanese coast, and how others eventually became vehicular ferries at Penang.

The "Z" has been succeeded by the RPL (Ramped Powered Lighter), not to be confused with the war-time RCL or Ramped Cargo Lighter which was a somewhat flimsy plywood powered lighter, capable of carrying one laden 3-ton vehicle in protected waters; many were made and used in Burma during the last war.

The first two (prototype) RPLs were built in 1961 and one of these was later sent to Singapore. Several more, incorporating some improvements in design have recently been completed and are intended for positioning at suitable points overseas. Weighing 56 to 58 tons light the RPL can be lifted by a large number of British ships and carried as deck cargo. Maximum loads are a Centurion tank, 50 tons of stores or four loaded 3-tonners. Twin Rolls-Royce diesels give a speed of 9 knots and there is excellent accommodation for a crew of six. One of the latest RPLs is shown in the accompanying photograph.

The West Germans have quite an excellent self-propelled lighter, known as a Mannheim craft, somewhat similar to, but half the size of a "Z" Craft. Their Hansa Line heavy-lift ships can carry it on deck and lift it out with a 120-ton derrick.

Apart from some RAF craft specially designed for use in the Maldives, and the Royal Naval Air Service lighters of catamaran-type construction for ferrying aircraft to and from ships and not, therefore, strong enough for military vehicles and stores, there are no other special vehicle-carrying lighters available for British use.

Pontoons

One can, of course, improvise by using pontoons joined together to form rafts or ferries, suitably propelled by commercially available outboard motors. Most pontoon equipment has the advantage of being readily adaptable for various other uses such as landing stages and causeways. Probably the best known is the American NL (Navy Lightered) Pontoon used to make, amongst other things, LST Causeways, Rhino Ferries and all sorts of barges. Though very robust, this equipment cannot be quickly "buttoned together" but must be assembled on the shore and then only with the help of cranes and semi-skilled labour. Rafts are surprisingly heavy and not easy to transport, weighing between 60 and 100 tons, depending on their composition; they must therefore be constructed on site or carried there by a heavy-lift ship or towed. All three alternatives present the planners with difficult problems involving time or shipping space. A few years ago however a commercial pontoon equipment, Storey Uniflote, came on the market. This equipment provided flexibility in use and easy assembly in the water by unskilled labour. Trials were carried out and the equipment was found to be operationally acceptable for use in sheltered waters. Unfortunately the coupler strength was inadequate for the more testing conditions imposed on open beaches. As a result of the experience gained in these trials, MEXE

Photo 3. An Armoured Recovery Vehicle wades ashore from a Z-Craft at the military port of Tandjong Berlayer, Singapore

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produced a purpose-design for a new pontoon equipment which shows great promise. A prototype will be available for test at the end of this year.

In order to fill the gap between the ageing NL pontoons and the new MEXE equipment, a limited quantity of Uniflote was purchased for use overseas. A lighterage raft from the original trials equipment has proved invaluable in Aden and continues to give excellent service (see photograph).

Miscellaneous Tugs and Barges

The ordinary dumb barge has not been mentioned yet, and much could be written of the different types, and shapes and sizes, but generally speaking none of these are eminently suitable for military operations and they are nearly all heavy and difficult to transport over long distances. Moreover, tugs must be provided also and, unless these are already on site or close at hand, a further strain is imposed on our limited heavy-lift shipping capability, for ocean-going tugs are in any case scarce and probably already committed to some salvage or other project. Due to their considerable weight and size (eg, a Tanac diesel-engined harbour tug of 240 bhp is 64 ft long and weighs about 60 tons light, while a 150-ton dumb barge of steel weighs nearly 50 tons), it will normally be impracticable to import a lot, if any, of these items into an overseas theatre of operations.

Some sort of tug will of course be needed for towing Dracones and it is intended that the new RE Workboat shall perform this function. Since Dracones are for liquids only they form a very special type of barge or lighter that will not therefore be considered in detail here. When full they are somewhat similar to an elongated iceberg in that their draught is surprisingly large and almost certainly much greater than that of the tug itself. Another feature of the Dracone happens to be a very valuable one for, unlike any other barge or lighter, this one can be rolled up when empty and stowed in a relatively small space.

Amphibians

Now all these lighters so far mentioned must be unloaded at or on the seaward side of the shore line. With an amphibian this particular link in the handling chain may be avoided and the craft can become a vehicle on land and motor on to suitable discharge points, thereby enabling greater dispersal, and so less vulnerability, to be achieved. There are many other advantages, including speed in handling operations, the ability to cross sandbars and use beaches quite unsuitable for conventional vessels or landing craft and the ability to avoid unexpected squalls and storms by simply motoring ashore. Principal disadvantages are a high initial cost and a more complex, and so more expensive, maintenance requirement.

The General Motors DUKW of World War II is probably the best known amphibian with its six wheels and 2½ ton carrying capacity, but it has long been obsolescent and must soon be replaced. Water speed moreover is very low and operation in a rough sea is hazardous. Only small-type cargo, such as supplies or jerricans, can be conveniently carried, though it is possible to take a large Conex container[1] provided its weight is not too great. I once saw a DUKW accept one of over 8,000 lb weight and reach the shore safely, but the sea was pretty calm and the Americans admitted they were taking a risk. Being more of a vehicle than a craft, British DUKWs are held by special

[1] A steel box 8 ft 6 in × 6 ft 3 in × 6 ft 10½ in high with lifting eyes.

Photo 4. One of the latest Ramped Powered Lighters. This one is fitted with Decca River Radar, Type 215 and a Fairway echo-sounder. The temporary masts and aerials form part of the Marconi Kestrel radio telephone equipment at present undergoing trials

Some aspects of ship to shore movement 4

MT Coys RASC and repaired by REME Workshops. Some LVTs (Landing Vehicles Tracked) are also held, but they are terribly slow in the water and not particularly suitable for offshore operations; river work is more their line and, though their tracks enable them to cross coral reefs and soft mud and beaches, they cannot really be considered as lighters.

Recognizing the DUKW's limitations both as regards cargo capacity and marine performance the Americans produced a really big amphibian called a BARC (Barge Amphibious Resupply Cargo) which, though it has four giant wheels each of 10 ft diameter, is hardly a vehicle but, as its name implies, a vessel. Nowadays it is known as a LARC 60 the initial letter denoting Lighter and the figure its normal capacity which is 60 short tons though in an emergency 100 tons can be carried; a bow ramp enables large and heavy equipment like the biggest bulldozers to be carried. This is an extremely useful lighter and the Americans have a number of them, in the Pacific and in Western Europe, though because of the gigantic cost (in the region of £80,000 each), probably not as many as they would like. Their width (over 26½ ft), however, precludes them from proceeding far inland, while their fantastic weight (90 tons) makes them a difficult transportation problem. The Americans have resorted to carrying them as deck cargo and just tipping them overboard, using an inclined chute, when valuable space in LSDs has not been available.

Recently a smaller and more handy equipment known as the LARC 15 (Lighter Amphibious Resupply Cargo 15 short tons) has been developed and tested. This also has a ramp and can carry one 3-tonner or a variety of other things such as three large Conex containers or six pallet loads of jerricans, or ammunition, which incidentally can be handled by forks from the side since there are removable canvas bulwarks. With a good water speed, wonderful surf capability and excellent performance in soft sand and over dunes this remarkable diesel-driven LARC can also be driven along main roads at 30 mph. Unfortunately its width of 14½ ft imposes certain limitations on its use as far as we are concerned.

A smaller amphibian still, the LARC 5, forms the third member of this family that the Americans have devised. This of course is for 5 short tons and there is no ramp. It has cut-away sides with removable canvas bulwarks as on the larger model but with the driver's cab for'ard as on the DUKW. Depending on the outcome of further trials with an improved version of this it is possible that British DUKW's may soon be replaced by LARC 5's.

Supra-surface Craft

Before leaving lighters, and rising from the sea to consider helicopters in the ship-to-shore role, let us first skim the surface of the water so to speak. Two types of equipment do this, one being the hovercraft and the other the hydrofoil craft.

Much has already been written about the former and several types are being currently evaluated in Britain. Some would appear to give promise of reasonably easy adaptation for military use and be capable of ferrying stores, vehicles and even tanks at speeds of 50 knots or more. As in the case of amphibians they need not be unloaded at the water's edge but can carry their loads well inland, provided the "going" is suitable. However, in spite of all their advantages many difficulties have still to be overcome, eg, high maintenance costs, the amount of spray and dust thrown up, etc and of course the

Photo 5. A Uniflote ferry brings a Centurian tank, just off-loaded from a freighter, to the shore at Aden

transportation problem looms again, for the hovercraft itself has got to be carried to the scene of operations.

In this country we do not seem to be at all interested in the hydrofoil method of propulsion, but both the USA and Russia are developing it to the virtual exclusion of the hovercraft. Both seem to be concentrating on the passenger carrying aspect, the US Marine Corps for assault troops and the Russians for fast river traffic on the Volga, Danube and other rivers. The latter have a 300 seater called *Sputnik* in service. Great speed (of the order of 45 knots) and immunity from swell and choppy seas are its particular virtues. Hydrofoil craft are in regular passenger use across the Straits of Messina, on the French Riviera, in Switzerland, Southern Norway and Japan. Doubtless a cargo version will follow, but this sort of craft, though wonderfully fast, cannot cross the shore line. Unless therefore it has amphibious characteristics, its loads must be transferred at that point, a vulnerable process that loses much of the time previously gained by the quick sea passage. The US Marine Corps has lately been testing a hydrofoil craft with retractable wheels (LVH).

Helicopters

The advent of helicopters into everyday life has been far slower than many people imagined a few years ago and neither the initial cost of a helicopter nor its maintenance charges have got appreciably less. Nevertheless many and varied underslung loads, from lengths of pipeline to a cathedral cross, have been carried, quite apart from cased rations, cans of water and other requirements in actual operations. In ship-to-shore work helicopters have worked from special carriers on many occasions carrying supplies as well as personnel, but apart from working to and from ships equipped with a special platform, usually on the poopdeck, in a reconnaissance or communications role, they have never been used to any extent for unloading normal freighters. The principal reason of course is that their rotor blades would be fouled by all rigging, shrouds, guys and posts, if they landed near cargo hatchways or flew too close. There are other reasons too, but in time they should all be overcome. Considerable progress has already been made by the US Army who have produced and successfully tried out several types of portable Ship's Wing[1] to enable helicopters to snatch loads brought up from a ship's hold and run outboard on a shuttle platform that slides on a framework or "wing" cantilevered at least 24 ft out over the gunwhale, ie, far enough to allow sufficient clearance for the rotor blades. The ship's winches provide the hauling power for the shuttle platform and there is a catwalk along the side of the wing for the hookup man.

In the American trials helicopter pilots used a simple system of transit posts and cards with edges horizontal to obtain first the correct line of approach and then the correct height and position. Only loads of about 2,000 lb were used in the early tests though it is claimed that with a stronger "wing" and more powerful helicopters there seems no reason why loads of 5,000 or 6,000 lb could not be lifted. By using a number of helicopters, say four to a "wing", all delivering to a point 3 miles away, snatches could easily be made every 2 minutes so, with say four "wings" per ship, something like 300 tons of stores per hour could presumably be landed. Theoretically therefore a complete shipload could be discharged in a day—an amazing

[1] Originally known as a HEAP (Helicopter Extended Area Platform).

Photo 6. The LARC-15 can carry a 3-ton vehicle through surf and deliver it "dryshod" beyond the beach. The bow incorporates an hydraulically operated folding ramp

Some aspects of ship to shore movement 6

thought, but of course nothing really heavy or bulky could be included. Such a performance of course would far outshine that of either landing craft or amphibians and get the supplies some distance inland at the same time. However, these figures take no account of the present high ratio of maintenance time to flying hours necessary in practice and it is likely to be some time before sufficient helicopters could in any case be spared for logistic purposes; nevertheless even two or three could be most useful in the ship-to-shore role and there would seem to be no reason why priority cargo or supplies should not be flown ashore from the upper deck, suitably altered if necessary, of an LSL?

During last year's Port Task Force Exercise "Pablo Two", an RAF Belvedere snatched some dummy loads in cargo nets each weighing about 3,000 lb from a Uniflote raft, under way in the anchorage and pointed into the wind, and brought them successfully to a transit area behind the beach.

Summary

From this review, which has of necessity been a rapid and somewhat superficial one, it seems that certain points emerge, the more important ones being:—

1. There is a continuing need for lighterage but special types must be easily transportable.
2. The introduction of logistic amphibious craft (including hovercraft) offer many advantages in terms of time, labour and reduced vulnerability.
3. Helicopters may have an important role to play in the discharge of priority cargo.

Bangalore Torpedoes—Jumbo-Size

By A. A. Willis

Forty-seven years ago I was responsible for the creation—and shortly afterwards the disintegration—of two Bangalore Torpedoes, the occasion being a trench-raid and the place the Western Front. Recently I turned up among some old papers the original of my subsequent report on the operation, and the editor has asked me to write an article about it.

I have no idea whether a Bangalore Torpedo means anything more to the present-day young Sapper officer than just another of those long-forgotten bow-and-arrow war gimmicks, but briefly its function was to destroy enemy wire entanglements, and it was invented in 1912 by the "QVO" Sappers & Miners at Bangalore. The original model consisted of sections of 2½-in dia piping made out of tin and filled with dynamite or gun-cotton; the sections were capable of being fitted into one another to the required length, ie, depth of the entanglement into which it was to be pushed; and it was fired by fuze from the "home" end. A full description can be found in page 133, Vol XVII (1913) of the *RE Journal.*

In August 1916, my Division (34th) was moved up from the Somme to just south of Armentières. This sector of the line had been static, not to say somnolent, for well over twelve months, and so that autumn the higher-ups decided to lay on occasional raids into the enemy's front line by way of keeping the troops—ours principally but the Hun by involvement—from getting into a groove. The general pattern of trench-raids was that two small parties entered the German line simultaneously about forty yards apart, worked inwards to each other, taking prisoners and generally raising hell, and then retreated the way they had come. Since these affairs lasted only ten minutes or so speed and surprise were of the essence, which meant that a path through the protecting wire at the entry points had to be cut beforehand. Hitherto this had been done surreptitiously by hand during previous nights: now somebody remembered Bangalore Torpedoes and decided that they should be employed. It fell to me to employ them.

I scurried round gleaning information about the things—the subject had not been included in our intensive five-month training at the SME the previous winter—and finally decided to make them out of 2-in internal diameter galvanized iron water-piping, the explosive to be ammonal which came in powder form and so made for easy filling. The next thing was to determine the length required, which involved two or three nights cautious reconnaissance in No-Man's Land. From this I discovered, with some dismay, that the Boche wire—which, on this "peace-time" front, they had been happily adding to, night after night—was anything from twenty to twenty-four yards in depth. Even with the longest sections of pipe available, 18 ft, I should need *four* for *each* torpedo. I was definitely working well up in the Jumbo-size class.

The raid had been set for the night of 30 September/1 October and it was now 24 September, so for the next week I was pretty busy. Here are the practical details of manufacture and delivery to customer:—

The eight pipe sections, lower ends temporarily blocked by wooden plugs, were filled from a high platform, each taking 25 lb of ammonal. The top ends were then similarly blocked and they were ready for transportation. Two of these plugs, however, were permanent as they were to form the nose of each torpedo. They were held firmly in the pipe by countersunk screws from outside and projected 6-in, being tapered off and thoroughly greased for easy and silent pushing into the wire.

The pipe sections were taken forward at dusk on the night to just behind the front line where they were assembled. Before joining any pair, after removal of the temporary plugs, either end of a 6-in long semi-circular tin sheet was fitted into the open ends and filled up level with more ammonal to obviate any shortage at the joints. Though hardly necessary, a loose No 8 detonator was also added for good measure to help carry the explosion on; the pipes were then screwed together outside the tin sheet.

A specially-made end plug was next fitted to each torpedo. These had two grooves, one for the leads from the electric detonator inside, the other for instantaneous fuze from an ordinary detonator—this latter to take care of any electrical failure. Fuze and leads were of course firmly taped down to the plug, which was itself also screwed into the pipe in case of any sudden strain coming on the leads and yanking the plug out.

When assembled the torpedoes were carried out into No-Man's Land and laid ready for pushing into the wire. I and my section-sergeant and two sappers accompanied them with the dynamo exploders and then paid out the leads and fuzes—which were on drums—back to a convenient, and we hoped reasonably safe, shell-hole about thirty yards behind. We brought both exploders (and fuze-ends) back to the one point to ensure simultaneous firing.

The actual pushing into the wire was done by special parties, as the weight of the two lengthy torpedoes would make it a long and tiring business and the raiders themselves would have plenty to do later. The men lay on their sides, alternating, and pulled the torpedo forward, a couple of feet or so at a time, by twisted rope grips which could be slid back as it moved in. I had further arranged for short bursts of machine-gun fire directly over their heads from our front line: this effectively drowned any sounds of the metal pipe on wire and pickets and acted as a "heave" signal for the men. During this operation the four RE paid out the wire and fuzes and kept them free from catching on obstructions.

No great difficulties were experienced, though the time-factor became a worry. As the torpedoes were pushed further and further in, the men doing so became more and more bunched, and increasingly fewer were able to work. Progress was thus cumulatively slowed down, as a result of which the machine-guns, under the covering noise of which the work was going on, overheated and delay was caused while others were organized into the game. Thus, though the torpedoes had been carried out into No-Man's Land at 10.30 pm it was not till 4.30 am that the working parties had withdrawn, the raiders moved up into position, and all was ready for firing.

Both exploders worked perfectly and the instantaneous fuze, spitting fiercely back at us, was not necessary. I realized afterwards, with shame, that I should *never* have employed it. Had one of the Verey lights falling at intervals into No-Man's Land landed on it it would have been more than unpleasant for the men pushing the torpedo in.

The RE party, its job done, retired with the exploders and drums, leaving the others to their noisy fun-and-games. I did not go forward to see if the gaps had been properly made, as I already had a pretty good idea. A couple of days previously, I had been ordered to put on a demonstration in a field behind the lines so that the higher-ups could see what we were aiming to do. For this I had made two small 24-ft torpedoes, the depth of a short length of entanglement put up for the occasion. The Divisional and Brigade Generals, a lot of Staff, and visitors from other divisions were present for this dress-rehearsal, and I became highly nervous. I went about explaining that *all* the wire might not be cut and there might be a few strands left for the infantry to deal with. Came the great moment, and the top brass crowded round the exploders. I asked them to retire, pointing out that my sergeant and I were only this far forward because we were actually doing the job, otherwise we'd be a good hundred yards away. This "Death or Glory" note sent them back twenty yards or so, and we fired.

To say it was successful would have been understatement. My inexperienced calculations had overlooked the additional explosive effect of the ammonal being confined in metal pipes; in addition, the wire entanglement, having been made copybook fashion behind the line, was almost a solid belt and thus more easily breached. In point of fact the torpedoes each blew a gap 60-ft wide completely clear of wire: the raiders could have gone through in line abreast. They nearly blew a gap in several staff officers too, as fragments whistled past them. My sergeant and I were of course crouching down;

they had insisted on standing up to "get a better view". Some of them were quite indignant and said it wasn't at all a safe demonstration: I felt like retorting that it'd be "all right on the night", if they cared to come along and see. The Lincolns captain in charge of the raid merely asked "Where *are* those few strands left for us to cut?"

It *was* all right on the night: prisoners were taken, with only three of the raiders wounded, and the Hun was very angry for days afterwards. Bangalore Torpedoes must have been employed many times subsequently during the First World War, but I like to think that none were as big as my pair of seventy-two-footers. "*Dear Sir, is this a record?*"

Grant's Crossing of the River James

By Colonel R. A. Lindsell, MC

Prologue

During the American Civil War, the Union forces under General Ulysses Grant threw across the River James the longest operational pontoon bridge since Xerxes crossed the Hellespont in 480 BC (See Appendix).

This length of operational pontoon bridge was, in fact, not exceeded until 21 Army Group bridged the River Maas in 1954. From a purely historical point of view, this operation is therefore worthy of note, but, when we consider the speed of construction, which was achieved in spite of indifferent organisation, we can only marvel at the high standard of training of the engineer troops employed and remark the apparent lack of progress in operational wet bridging techniques during the past century.

Union Army Engineer Organization and Equipment

At the outbreak of the Civil War, the sole regular engineer unit of the Union Army was one company of "Sappers, Miners and Pontoniers", comprising approximately 100 men. In June 1862 a further three companies were raised and together with the original unit were formed into an Engineer Battalion of four companies with an establishment of 600 officers and men.

Their bridging equipment had been standardized as recently as 1858, following extensive trials, during which both india-rubber cylinders and corrugated iron shells had proved a failure. A decision was then made to standardize on two types of equipment:

(a) a canvas pontoon with light-weight superstructure to form an "advanced bridging train" to accompany the cavalry. This was light, strong and easily repaired, but suffered from the disadvantage that it could not support any weight when grounded; and

(b) a wooden pontoon modelled on the French "bateau militaire", which with its superstructure formed "the main bridging train". This pontoon weighing 1,600 lb was carried on a special low pontoon carriage (see photo 1) drawn by four horses, from which the pontoon could be launched directly into the water. The pontoons were spaced at 20-ft intervals with stringers laid on the gunwhales. Photo 2 shows a typical bridge formed from this equipment.

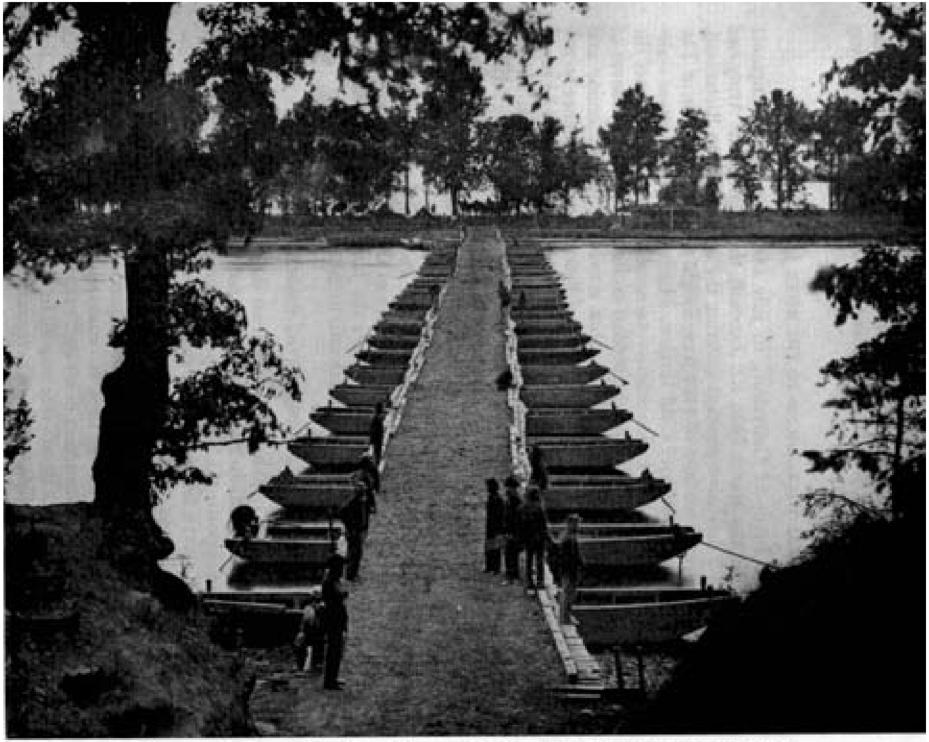


Photo 2. A typical bridge formed from standard equipment of the main bridging train.

Grants crossing of the River James 2

The allocation of bridging equipment was on the basis of one train of fourteen pontoons and two trestles to each Corps with additional equipment held in Army reserve for special operations.

It is of interest here to recall an extract from the directive of General Barnard, US Corps of Engineers, who directed the development of this equipment:—

"No makeshift expedient, no 'ingenious' invention, not severely tested by severe experiment, no light affair, of which its alleged chief merit is that of lightness, will serve to carry an army with its columns of men, cavalry, countless heavy wagons and ponderous artillery across broad rapidly flowing rivers with certainty and safety".

Historical Background to the river James Crossing

Following the battle of Gettysburg in July 1863 (see "Chief Engineer at Gettysburg" in the March 1963 *RE Journal*), the Confederate Army had fallen back into a defensive position covering the approaches to Richmond, and here in the early summer of 1864 were fought the bloody battles of The Wilderness, Spotsylvania and Cold Harbor, which resulted in virtual stalemate and the loss of 56,000 Union soldiers. General Grant, commander of the Union forces, then resolved upon the boldest and most skilful manoeuver of his career. He planned a powerful left hook across the Chickahominy and James rivers to capture the important town of Petersburg and thence to roll up the Confederate defences from the rear, (see map 1). To do this he proposed to disengage the entire Army of the Potomac under General Meade, amounting to some 10,000 men, and to move it with all its supporting artillery and baggage trains over country lanes to a point on the Wyanoke peninsular, some 15 miles east of Petersburg on the James River, where his engineers had selected a possible crossing place. On the night of the 11–12 June, 1864, the disengagement of V Corps of the Army of the Potomac began and by the evening 14 June the leading elements were across the Chickahominy river at Coles Ferry, heading for Wyanoke, where the James river flowed fast and wide between marsh fringed banks eastwards to the sea.

Reconnaissance of the Bridge Site

The James river is a navigable tidal stream for over 100 miles from Fort Monroe at its mouth to Richmond. For the greater part of its length it is wide and shallow, but opposite the Wyanoke peninsular it narrows to some 2,000 ft with a depth of 12–15 fathoms and a swift current. The tidal range at the time of the crossing was some four feet. On 12 June, Lieut P.S. Mitchie, Corps of Engineers, (later a Professor at West Point), reconnoitred the Wyanoke peninsular and recommended—"a site three-quarters of a mile upstream from Fort Powhattan—width of river 1,992 ft—east approach requires clearance of trees—on west bank construction of a 1 on 3 ramp and a roadway to connect with the Petersburg Point Road" (see map 2). In the afternoon of 13 June, the report was approved by General Grant personally and orders for the crossing were issued.

Construction of the Approaches

By 1600 hours on 13 June, Union scouts were across the river and cleared Confederate sharpshooters from the far bank. A party of 150 axemen then began work on the near bank and by nightfall had cut and trimmed 1,200 ft of timber in logs averaging 6 inches in diameter and 20 ft in length. A further 3,000 ft of timber was floated down a neighbouring creek and was rafted over to the far side.

During the night 13–14 work continued at a steady pace with engineers and infantry working side by side on both approaches. In the worst places large tree trunks up to 3½ ft in diameter were dragged into position. During this phase the engineer troops engaged were two companies of the New York Volunteer Engineer Brigade under the direction of Brigadier General Godfrey Weitzel (Chief Engineer of the Army of the James). At dawn on 14 June, two companies of the regular engineer battalion under Captain George Mendell arrived, accompanied by Major James Duane (Chief Engineer of the Army of the Potomac). The latter then took charge of the operation, as Brigadier General Weitzel gallantly waived his rank and offered to serve under Duane, who was much more experienced in bridging operations.

The situation at this time is graphically described by Captain Mendell. "On June 14 the Battalion arrived at the James River and found there several companies of the First New York Volunteers. The boats with their material were scattered in confusion over the low marshy ground along the shore and the volunteers could not be persuaded to go into the mud to get the boats into position. At the word of command 'to build bridge', detachments of my regular battalion, with NCOs leading, jumped into the mud and water almost to their necks and by commendable zeal and energy succeeded in one hour in building a bridge abutment 150 ft long reaching to low water level." This account hardly does justice to the New York volunteers, who had laboured all night on the approaches, and must by this time have been utterly exhausted.

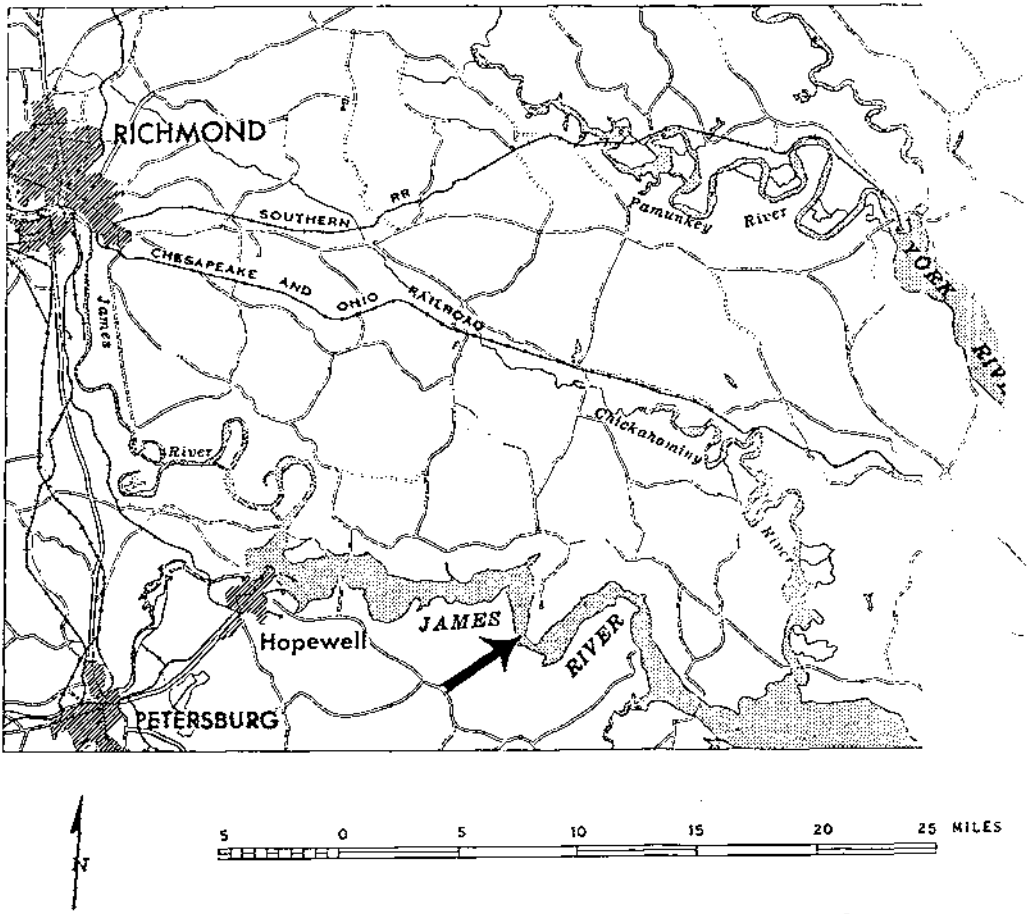
By 0930 hrs, the approaches on both banks were completed and on the near bank the floating ramp 150 ft long over the tidal marsh was in position. It now remained to construct the main floating portion of the bridge.

Provision of Material for the Floating Bridge

Apart from the bridging equipment held by the two companies of New York Volunteers, which was used in the construction of the floating ramp, as described above, no bridging equipment was available from Corps or Army resources, since all had been earmarked for the crossings of the Chickahominy River and other minor water obstacles.

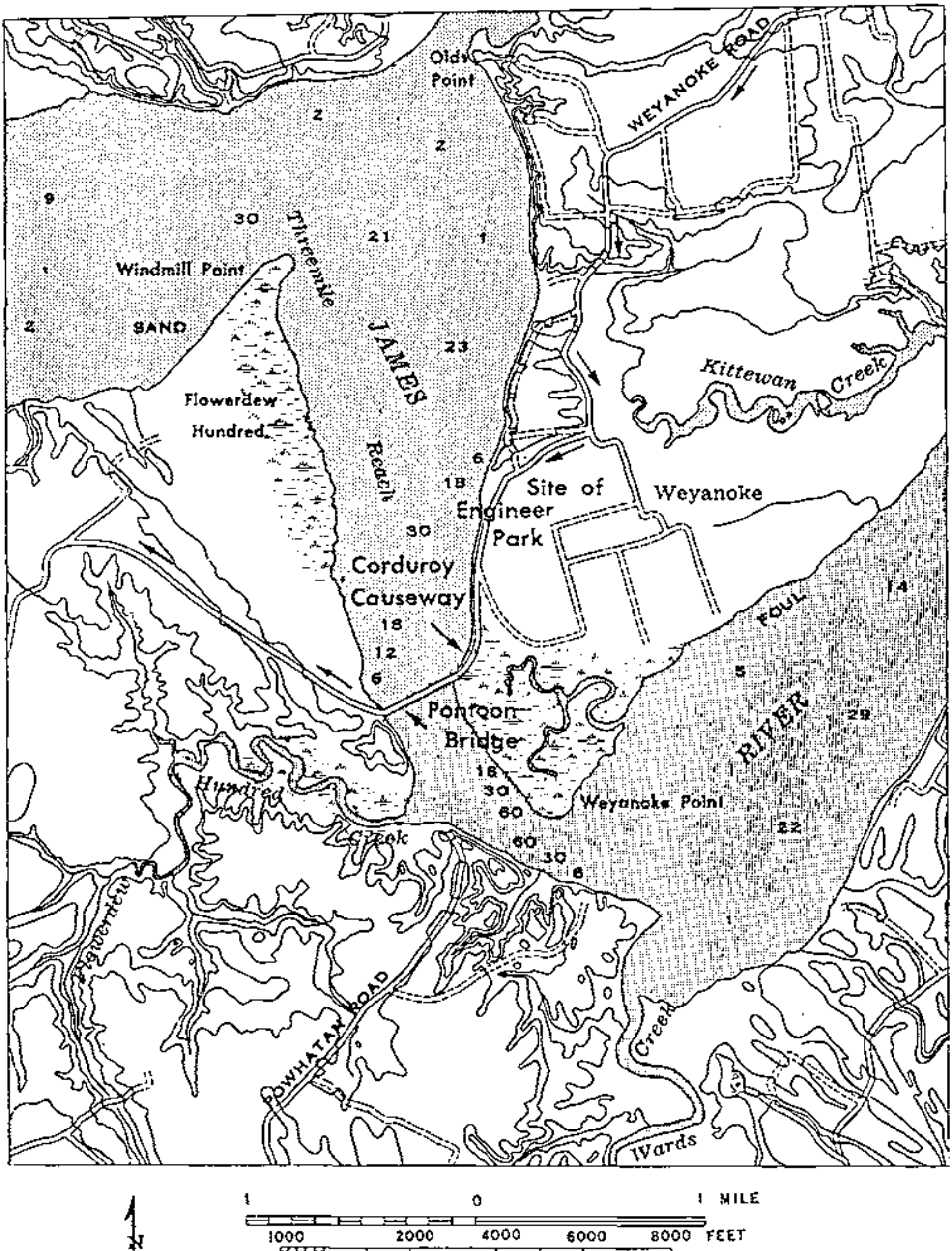
Reserve bridging equipment consisting of 155 pontoons (sufficient for 3,100 ft of bridge) with superstructure was held at Fort Monroe at the mouth of the James River under the control of Brigadier General Benham, who commanded the New York Volunteer Engineer Brigade. A few days previously he had been warned to have this equipment ready to move at short notice. However, due to a misunderstanding, orders to move the bridging equipment up the river to Fort Powhattan near the bridging site were not received until 0900 hrs on 13 June. The pontoons were hurriedly assembled into rafts for towing upstream and left Fort Monroe at 1400 hrs that day to cover the distance of some sixty miles to their destination. At dawn on 14 June, the engineer officers at the bridge site expected to see the rafts rounding the curve at Fort Powhatten at any minute. The advance guard of the Army of the Potomac was not far off, the bridge approaches were almost complete, so it was vital to begin construction of the floating portion of the bridge at first light. A despatch boat was eventually sent downstream to investigate and found the rafts

MODERN MAP SHOWING LOCATION OF JAMES RIVER CROSSING BY THE UNION ARMY OF THE POTOMAC. 14/16 JUNE 1864



Crossing place indicated by black arrow. Map No. 1.

MAP SHOWING POSITION OF PONTOON BRIDGE
AND APPROACHES. JAMES RIVER



Route of Union Army shown by arrows. Map No. 2.

Photo 3. View of completed bridge over River James from the near bank.

Grants crossing of the River James 3

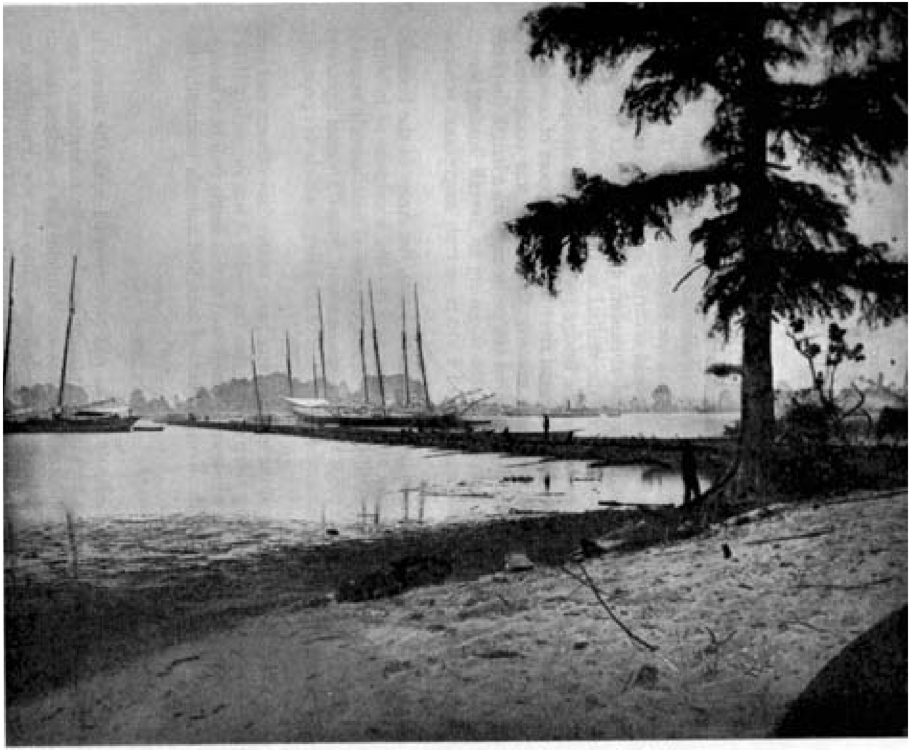


Photo 4. View of the completed bridge from the far bank.

Grants crossing of the River James 4

anchored off Jamestown Island, with the Captain in charge asleep, having completed less than half the journey! History does not relate what happened to the unfortunate Captain, but he must have "stopped an imperial rocket".

The convoy got under way again and finally reached the bridge site at 1200 hrs, some two hours after completion of the work on the bridge approaches.

Construction of the Floating Bridge

On arrival at the site the rafts were split up and the boats and superstructure were distributed equally on both sides of the river. The construction party comprised two companies of the regular battalion (each of 100 men) and two companies of the New York Volunteers (each of 110 men) giving a total force of about 440 men.

Captain Mendell of the regular battalion commanded the troops engaged under the overall supervision of Major Duane (Chief Engineer of the Army of the Potomac). Actual construction began at 1600 hrs on 14 June and we are told that the bridge was constructed simultaneously from both shores "by successive pontoons in accordance with the Pontoon Manual". To enable the central section of the bridge to be held securely in water up to 88 ft deep, six schooners were brought up and anchored, three on either side of the bridge, to which the pontoons of the central section were then made fast (see photos 3 and 4). A section of the bridge 100 ft wide was designed to be disengaged to allow passage of essential river traffic in support of operations upstream. By 2300 hrs the same evening the bridge was completed—a construction time of 7 hrs. It comprised 101 pontoons with a length (between previously constructed ramps) of 2,020 ft, giving an overall floating length (including the 150 ft floating ramp) of 2,170 ft—a truly magnificent achievement.

At daybreak the following morning (15 June), the Army of the Potomac began to cross the bridge and for the next 40 hrs a column of infantry, artillery and wagons some fifty miles in length poured continuously across it without interruption, except for damage resulting from "a vessel upstream slipping her anchor and carrying away part of the bridge, which was promptly restored".

The officer in charge of the maintenance party writes "my officers and men were scarcely allowed any sleep during this time—for it was in anxiety that I saw the destinies of the whole army committed to this single frail boat bridge. I did not dare to stop the living stream of men and animals to sheathe the decking".

Conclusion

Unluckily Grant's brilliant stroke was not crowned with the success it deserved. Due to delays and misunderstandings between subordinate commanders, the attack on Petersburg was not launched in sufficient time to prevent Lee switching his forces to its defence. Thus the war dragged on for another year to its inevitable conclusion at the Appomattox Court House.

In spite of this, the crossing of the River James by the Army of the Potomac will go down in military history as a remarkable feat of arms, made possible by the high standard of training and discipline of the enlisted men and by the cool and skilful direction of the officers of the Corps of Engineers of the Union Army.

Photo 5. A recent photograph of the bridge site, taken by the author.

ACKNOWLEDGEMENTS

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APPENDIX

List of the Longest Operational Floating Bridges

1. In 493 BC Darius had a bridge of boats constructed across the Bosphorus, where the straits are 3,000 ft wide. The chief bridge builder was Mandrocles of Samos.

2. In 480 BC Xerxes, Darius' son, had a bridge of boats constructed across the Hellespont (the Dardenelles) 5,000 ft in length, but this was destroyed before completion by a storm. Subsequently, the Chief Engineer was beheaded and the water given 300 lashes and a pair of manacles was thrown in to punish and shackle the gods of the waters. A new pair of floating bridges were then constructed, one using 360 "triremes" and "pentecouters", and the other 314 vessels.

3. In June 1864, the Union Armies under General Grant constructed a pontoon bridge across the River James, as described in the accompanying article, length 2,170 ft.

4. In February 1945, a class 40 Bailey Pontoon bridge was constructed across the flooded River Maas at Gennep by 7 Army Troops Engineers (CRE Lieut-Colonel (now Brigadier) Tom Lloyd). The total length including some crib piers was 4,008 ft.

Note. The above list does not include floating bridges constructed by civil authorities in peace time.

Photogrammetry

The following is an edited transcript of the discussion on Professor Thompson's paper entitled "Photogrammetry", reproduced by courtesy of the Royal Institution of Chartered Surveyors. Professor Thompson's paper was published in the February issue of The Chartered Surveyor *and the December 1962 issue of the* Royal Engineers Journal. *The Meeting was held at the Royal Institution of Chartered Surveyors conjointly with the Institution of Royal Engineers on 28 January 1963. The RICS President was in the chair.*

Major-General A. H. Dowson (Director General, Ordnance Survey); I have always found Professor Thompson stimulating and usually provoking, and I think he has lived up to this reputation.

In the Ordnance Survey we have a well-known file labelled "Esoteric terms". It is the legacy of a committee which General Brown set up in order to make some sense out of survey jargon. I suspect that some people take the view that the word "photogrammetry" is jargon, and I am glad that Professor Thompson gave us a dissertation on its meaning and its shortcomings. He also threw a number of bricks at the word "engineer", and I wonder what he thinks of the term "photogrammetric engineer."

The 1933 edition of the Oxford English dictionary defines photogrammetry only "as the art of surveying or map making from photography". I think that epitomises the rapid advance which has taken place in a very short space of time. The number of applications of the art or science of photogrammetry beyond the prime one of topographical surveying is extraordinary. For instance, as long ago as 1912 a German invented what was called a "stereoplast" which was devised to make busts from photographs, and more recently the French have used the same technique for making facsimiles of ancient Egyptian statues in Nubia. One cannot help thinking of the possibilities of this technique from the point of view of having a suit made! There are also applications in medicine, engineering, archaeology and even in traffic accidents.

It is interesting that the history of photogrammetry goes back over a hundred years. The father of photogrammetry was an astute Frenchman named Colonel Laussedat who, about 1850, produced the first practicable procedure. In those days of course it was largely non-topographical, but the impetus of the First World War and the invention of flying lent tremendous support to its use in topographical surveying. The early names amongst the developers were largely French, German, Austrian, Italian and Swiss. The Continentals, with their ingenious minds and high precision instrument industry, were the first to develop this complicated machinery which we see in use today; but there are also well-known names in the British Commonwealth and some British names also. Two of the best known are Brigadier Hotine and of course Professor Thompson. Brigadier Hotine, who in the early 'thirties was appointed to the War Office Air Survey Committee, was really the first to produce a simple and practicable way of making maps from air photographs. I should not be surprised to find that he has been responsible for greater coverage of good, practical mapping than any other single individual. Apart from that he has, of course, made tremendous contributions to both the theory and the literature of the subject.

Professor Thompson not only teaches but he invents. Before the war he designed and constructed a stereoplotting machine which was unfortunately destroyed during an air raid. He also designed the Cambridge Stereo Comparator which we still use. More recently he invented what is now called the Thompson-Watts plotter. He also had a great deal to do with the early years of the British Photogrammetry Society, and is now its President.

I detect a slight suggestion in Professor Thompson's paper that the National Survey Department has been a little slow to exploit the high potentialities of this technique. I would not disagree, but I would emphasise that hindsight is easier than foresight; it is so much easier to look back and to say what you think on reflection we might have done. I think we would have been wise to exploit the modern techniques earlier than we did, even if it meant buying, as it did, foreign equipment. I hasten to add that we have six or seven Thompson-Watts machines in the Ordnance Survey now! Moreover the Ordnance Survey has pioneered as a practical working measure the system of analytical aerial triangulation which Professor Thompson has referred to in his paper. Indeed, the Ordnance Survey has gone further with that technique than anybody else.

Professor Thompson mentions in his paper the value of speed. Whilst I can see the enormous advantage of the speed of the technique to our friends in the companies, I must say that to us in the National Survey Department economy is the most important factor, and in fact we use this technique now to the extent we do because we have found that it gives us the result we want very much more economically than the older ground methods.

Professor Thompson also referred to our inability to meet special needs in certain cases, and I need not elaborate on that. I think he is absolutely right. We have as the National Survey Department the aim of satisfying the greatest number of users, official and private, and moreover we have to act within the compass of a government directive which in fact is based on the advice and recommendations of a committee set up for the purpose. The effect is to make room for the work of certain companies which undertake the work commercially, and I think it is right that that should be so. I have the greatest admiration for what they do, and whilst I believe some of them are a little anxious sometimes about the powers of attrition of competitors who perhaps are not quite so reputable, referring to something which Professor Thompson wrote in his paper, I would not think it proper for a professional society such as the RICS to try and maintain a black list of disreputable practitioners or a white list of reputable practitioners. This and other professional societies have their own way of dealing with their members, and I think it is better than this suggestion.

He also suggests that we should get together and produce a pamphlet on the characteristics of this technique for the benefit of the potential clients. On this I will only repeat something that was said to me the other day by a stockbroker friend. He is a member of a large firm and they put out monthly advice notes to their clients, and on finding that his advice differed from the advice given in the note, I questioned him about it. He replied "That is average advice. It is a kind of average of what we all think. None of us would agree with it all, and some of us with not any of it." I suggest that might be the end result of trying to produce advice on that basis, and average advice is not anything like as useful to clients as the proper, wise and considered advice of the man who knows what he is talking about—in fact a consultant. Professor Thompson mentioned the possibility of consultants as the proper professional link between the client and the operator. Frankly, I believe there is room for a man of this kind. I differ from Professor Thompson when he states that he does not think that any of the likely clients would be gullible. I think they are sometimes, or perhaps I should say ignorant. The effect of this and competition may result in the client not really getting what he wants—not because of any knavery, but because he does not know what he wants. I think that, as in other professional fields, the function of the consultant can be to tell the client in the first place what he does want, and having told him what he really wants, to see that he gets it. I think further that the existence of a consultant of this kind might very well in the long run benefit the companies.

In the welter of machinery and theory which we have, do not let us forget the man behind the machine. I think that Professor Thompson's greatest contribution to the whole subject lies in the teaching he imparts at University College.

Professor E. H. Thompson: In the nineteenth century a great deal of use was made of photographs taken not from aeroplanes but from balloons, and this is an aspect of the subject which is now neglected. I think there are instances in which the balloon would be much more useful than the aeroplane, and for two reasons. First, at low altitudes you get better pictures from it, and, second, it is cheap for small surveys. We have done some work at

University College with balloons, and I am convinced that they could be very valuable. Archaeologists engaged in digging a large and complicated site require plans at each stage of the operation, and this requires laborious surveys for which work has to stop. Photographs from a balloon from a few hundred feet can be obtained rapidly and measured later.

Another very important pioneer was Vivian Thompson, an RE officer who was killed in the 1914–18 War. He was the first person in the world to invent, design and have constructed the analogue plotting machine. He produced an excellent instrument which is now in the Science Museum, and he had every intention of making it better and fully automatic. He put his scheme to the War Office in 1912 but no possible use could be seen for this instrument, and Thompson was not allowed to proceed with its development.

I do not think I said anything in my paper to indicate that certain organizations in this country had been backward in using photogrammetric methods, but if we have been backward in producing photogrammetric equipment, I owe a great debt for the support I have had from the Ordnance Survey in helping in our efforts to get into this market. I started serious work on the design of my equipment in 1951: Zeiss had produced a workable instrument for photographers in 1914 and for air photographs in 1920, which gives some idea of how far we were behind. But for the great support of the Ordnance Survey and the Overseas Surveys we could not have done anything at all.

Mr C. W. Phillips (Archaeological Officer, DGOS): Professor Thompson has raised the possibility of the Ordnance Survey using photogrammetrical methods for surveying earthworks. I do not know anything about photogrammetry, but I do know something about the problems involved in the effective survey of antiquities, and whilst I am prepared to admit that the main details of sites in this country can be surveyed by photogrammetrical methods, the problem is not disposed of there. We are already having this experience with the 6-in survey of Scotland now being carried out by the Ordnance Survey. It is possible to plot down large numbers of sites of various kinds, but it is not possible to finalise that work in any way until you have been on the ground. In the north of Scotland there are no large earthworks. Most of the sites are abandoned crofts of the nineteenth century or small stone forts; but when we come to the great earthworks of some other parts of Britain, the problem which faces us is to make up our minds what an earthwork really consists of. By that I mean that you often find bits and pieces of earthwork lying around which are not strictly speaking part of it and whose true character can only be assessed by ground examination.

As far as aerial photography generally is concerned in relation to ordnance survey work in archaeology, I suppose it is well known that O. G. S. Crawford, my predecessor in this post, was of course the great British pioneer in this matter. He was not, however, the first pioneer. As long ago as the eighteenth century ground observers in this country were already noticing phenomena of various kinds in the way of soil discoloration and differential vegetable growth which they suspected had something to do with the existence of former ancient sites. It was only when men got off the ground that they began to know what they meant.

It was a certain Royal Engineer in India in the 'eighties who carried out a complete survey of the monuments of Allahabad from a balloon, and Nadar, the famous French photographer did a great deal of photography from balloons. Crawford was in the Royal Flying Corps and he made his first observations in France during the course of the war, so that in 1920 when he was appointed first archaeological officer, he brought this technique to bear as soon as possible.

We should use aerial photographs a great deal. It is useless to send people out to make investigations of an area for the first time without their having studied it from aerial photographs as far as possible. But the point is what aerial photographs? Where do we get them? There is a great shortage of them. There is no official air photography of any kind for archaeology. We have to rely on the charity of people who fly at week-ends from local clubs, and Dr Joseph is conducting a magnificent piece of work at Cambridge for air-photographic archaeology. I should also like to point out that even if we could have a larger measure of air photography directed towards us than we do, I do not believe that we should get to know much about the potentialities of aerial photography in relation to archaeology until photographs have been taken of selected sites for every day in a whole year to get to know more about the effects of weather, differential vegetable growth, soil coloration and so on.

Professor THOMPSON: As far as the mapping of the hill forts is concerned, Mr Phillips is emphasising, what I have said in my paper, that non-topographical photogrammetry is difficult if not impossible unless whoever is carrying out the operation knows what he is about. The point I tried to make was that, having decided what you wish to show on a large-scale plan of a hill fort, it is then extremely laborious to work on the ground particularly because most of the work is in drawing contours.

Mr W. P. SMITH (Technical Director of Fairey Air Surveys): I should like to support what Major-General Dowson said in linking the names of Hotine and Thompson. Those of us who occasionally travel in foreign parts on surveying business know that recognition of British photogrammetry is unquestionably linked with their names.

One of the points which Professor Thompson made concerned the question of pre-marking, and I think that the development of the technique for railway surveys exemplifies the advantages which have followed the introduction of the very much improved lenses which he mentioned later. In the early days of railway surveys there was a vast amount of field work to be done on checking up on detail which was not visible on the photography. This increased the cost greatly. There was also a large amount of pre-marking to be done.

I imagine that our commercial surveyors will welcome Professor Thompson's reference to private enterprise—not only for what he has said but for having mentioned them at all. They are possibly pleased to hear comment on their development and their work spoken here, in public, at this meeting. I am especially glad that he mentioned two points: one, the activity of some of them in foreign countries, without political label, simply as British commercial contractors facing all the financial, political and climatic risks involved. The other was the work done in this country on large scale surveys. The acceptance of photogrammetry by local authorities for engineering surveys has been almost entirely the result of efforts by private enterprise and it is gratifying, now, to hear from the authorities themselves that the accuracy of photogrammetry is no longer in question. This is not by any means to say that mistakes do not occur, and the wise companies will certainly appreciate that neglect of routine checking will very rapidly damage a good name, in the short term, and commercial profitability in the longer term. They are also wise to be concerned for maintenance of standards, particularly as applied to techniques and accuracies offered. In this connexion Professor Thompson's suggestion for the formation of a committee to prepare and issue a pamphlet setting out the characteristics of mapping from air photographs is warmly to be welcomed. I would add this suggestion: that the present opportunity be taken to prepare draft specifications for very large scale photogrammetric mapping in the same way as was done for medium and small scales at the Commonwealth Survey Officers Conference in 1956. This might require assistance from the civil engineers, for we all know how different can be their approach from that of the simple land surveyor, and the marriage of their needs with the facilities offered by photogrammetry is by no means complete. I am certain that such a specification would be generally welcome.

Still in the context of private enterprise, Professor Thompson has properly drawn attention to the private companies' willingness to try out methods which could have an early effect on output and cost. This is doubtless true, but I imagine that the private companies regret the difficulty experienced in applying this enthisiasm to extensive medium scale surveys as well as to local large scale work. The application of certain airborne auxiliary aids, Aerodist for example, or APR, require large capital expenditure and may best be assessed in the mapping of areas of a size unlikely to be encountered in the order of a private client. They tend to be projects eminating from government agencies, rarely undertaken under contract. Nevertheless, private enterprise in this country will recognize how much it owes to our own Directorate of Overseas Surveys and Directorate of Military Surveys for contracts for photography overseas and for research in this country respectively. I mention this for the record, because without it this first extensive comment on private enterprise air survey in this country would surely be incomplete.

Colonel McIntyre: I am concerned with the use of aerial survey, to choose sites which are suitable for airfield construction. The two items which are required quickly, at short notice, are (*a*) a contoured plan, vertical interval of 1 ft, of an area 3 miles square and (*b*) information on the types and bearing pressures of the soil in that area. I would be grateful for information on this aspect and in particular (i) how long would it take to produce the contoured plan, assuming that expense is no object, for an area 3 miles square, scale 1/1000, contours at 1 ft intervals, and (ii) how do you determine the soil type, and what degree of accuracy is obtained in this classification, with particular regard to depth of strata.

Mr Smith: This is a difficult problem, and one must begin by making certain assumptions. The first is it is possible to obtain ground control. That is not always the case in military surveying, and a number of us have been exercised as to how to manage without it. It can be done, but generally speaking it requires auxiliary aids. One can do something by taking small-scale photographs covering a large area around a potential airfield site in order to obtain horizontalizing data. Then by taking specific points from the small scale photographs and transferring them to the larger scale it might be possible to draw this narrow interval contour. The questioner asked how long would it take to produce? How much contouring is really the issue in this case, for if there is undulating ground one can have a large number of 1-ft contours. At the same time, one has to consider how many machines are available for doing the work. To put it simply in terms of commercial companies' methods, namely, how many man hours, I should say for an area of 2,000 acres something between 1,800 and 3,000 man hours.

With regard to the second point about soil type, I am not aware of any aerial photographic method which *per se* can distinguish soil strata below the surface. I would say that soil surveys by photographic methods are largely deductive. In general the practice adopted is to delineate obvious boundaries on a photographic moasic. These will take into account vegetation, drainage, changes in tone, etc., and may not all be soil boundaries. Having drawn the boundary map, it is then taken into the field, and by sampling in key areas one can deduce a classification which can then be applied to the remainder of the area. The real use of the photograph is to draw boundaries and by sampling to decide what is contained within them.

Colonel McINTYRE: I asked that question merely to find out whether there was a process of which I had no knowledge which would shorten the planning process of building airfields in a country we could not get to beforehand. I wanted to know whether this process of vertical interval of 1 ft was a matter of days, weeks or hours. I am still puzzled by 3,000 man hours. The second matter was to try and find the strength of soils.

Major-General T. H. F. FOULKES (Engineer-in-Chief): Professor Thompson referred to a precision of one in 8,000. This is the age of precision and things are becoming more precise as we go along. Can Professor Thompson predict a higher degree of precision than that in a reasonable space of time? Can he, for instance, suggest it might be twice as precise in ten years' time?

Professor THOMPSON: I should have thought that was not unrealistic. The development, for example, of photographs taken with the grid would help in that respect. I did mention what I thought would ultimately limit accuracy, namely, the turbulence of the atmosphere, but there are other limits. For instance, the effect of movement of the aeroplane is certainly very difficult to overcome. One can get sharper pictures by moving the film in the camera; but this introduces geometrical errors depending on the relief of the ground. If this is flat the moving film technique would go a long way to improve the sharpness of the picture and measurements made from it.

Mr P. G. MOTT: I should like to thank Professor Thompson for the kind things he has said about private air survey companies. It may seem a little churlish perhaps to criticise his own criticism of the private companies, namely that we do not like any method which involves computing. That might have been true some ten years ago, but I do not think it is so today. I can of course only speak for one company, but I feel sure others will endorse what I say. The civil companies today are making considerable use of computing methods. In our company we have at least two of our staff who are trained in writing programmes, and we use them quite extensively for work on our aerial triangulation and we are now in the process of working out a programme for block adjustment. The old, radial line technique has almost gone out of use except for controlling of mosaics.

We also use computing methods for volumetric data, for computing the capacity of reservoirs, cut and fill in earthwork, and in assessing coal stocks. It has to be appreciated that the stereo-comparator such as the one Professor Thompson illustrated costs very nearly as much if not more than some of the analogue type plotters, and it has the disadvantage that it only serves one purpose, namely the read-out of co-ordinates for aerial triangulation. A national institution, such as the Ordnance Survey, with a long term programme of a certain type of mapping stretching far ahead can gear itself much better to the use of the stereo-comparator than can be done by a private company. The private company must be able to carry out aerial triangulation on the instrument at times and to use it at other times as a plotting instrument when there is no aerial triangulation required, since he cannot afford to keep an expensive piece of equipment idle. This I believe is the main reason why the stereo-comparator has not found favour so far in the commercial field of aerial surveying. But of course this does not in any way prejudice the use of computational methods.

Professor THOMPSON: I am pleased to hear I was wrong about computation in the private companies. With regard to the question of stereo-comparators versus analogue plotters, one must not lose sight of the fact that, for the same amount of money, the stereo-comparator has a potential accuracy of measurement certainly double that of the analogue plotter. Whether its accuracy can be used is something that has yet to be proved. But it is not fair to compare prices of instruments of differing accuracies. To produce an instrument as accurate as the best analogue plotter today would probably cost a quarter of that of the Hilger and Watts comparator. The aim of the stereo-comparators now on the market is more accuracy.

Major R. M. SILBERRAD (Air Survey Officer, Ordnance Survey): There is one point in the paper on which I venture to take issue. It concerns the statement: "The years have shown that no high-class work can be produced by a flying organization in which training, promotion and cross-posting are in the hands of an authority that has no responsibility for (even if it has any interest in) the quality of the ultimate product."

The Ordnance Survey is not lucky enough to have its own flying organization at the moment, but that is the only part of the whole chain of the air survey work which we do not do ourselves, from flight planning down to the production of the document ready for field completion. At the moment the Ministry of Aviation Flying Unit flies aircraft for us which we supply with cameras, camera operators and the necessary flight planning information. We get excellant results from the Ministry of Aviation, and I should like to record this credit to them. At the moment they cannot meet our requirements in quantity, although they can in quality, and it is for that reason that we are now considering a commercial contract with one of the air survey firms to hire an aircraft to increase the quantity of flying we require this year and probably in future years.

Professor THOMPSON: Again I am glad to be proved wrong. On re-reading my remarks I feel that I have not explained myself entirely as I intended. I intended to include the photographic side of the work over which the Survey Service in the Army has little or no control, whereas the Ordnance Survey has control over processing, camera calibrations and photography in the air. I probably did not word this very well.

Brigadier L. J. HARRIS (Directory of Military Survey, War Office and Air Ministry): The RE Survey Service works very closely with the Photographic Reconnaissance Force of the Royal Air Force to whom Survey Liaison Sections of the Royal Engineers are attached. The organization and manning system is very satisfactory. It must be remembered that the Royal Air Force is trained and equipped for war. Their aircraft need to fly high altitudes and at high speeds, and survey photography may need to be taken in time of war.

The difficulty is more one of finding equipment which will satisfy both the needs of war and of peace.

I am very glad that Colonel McIntyre posed the question about surveying for airfields. It is a problem which will vary with the conditions under which the survey is to be made. As an example, such a problem was put to me before the invasion of Malaya in 1945, because fighter cover was required over the invasion beaches and there were no ready-made airfields within reach and available to us. The island of Phuket was selected as a likely locality for an airfield. At the first planning meeting which I attended, we could only produce an Admiralty chart of the coastline and nothing else. We had to adjourn our meeting until "RE Survey" produced a contoured map of the island. Fortunately the contour interval requested was far greater than that now required by Colonel McIntyre, and we produced the map from air photographs in about a week as far as I can recall. The planning for the airfield was then continued.

St Helena Epilogue

By Brigadier C. E. M. Herbert, CBE

Most of the things written about Napoleon and St Helena have had some sort of political bias. This is a very simple little account taken from notes and letters of my great-grandfather, Mr George Bennett of the Commissariat (later, Control) Department. He retired in South Africa after serving there. I was born in his house at the Cape and can just remember him. A reason for sending this to the *Journal* is that he refers several times in his notes to the RE officer who was responsible for the exhumation arrangements.

Mr Bennett was always greatly interested in anything to do with Napoleon, having been born in St Helena in 1816 during the Emperor's captivity. His father was an officer of the permanent garrison in the service of John Company (the Honourable East India Company) to whom the island then belonged. His mother had been standing by the steps of the glacis at Jamestown when Napoleon came ashore on the evening of 17 October 1815. Observing a lady standing above him, he politely saluted her. Anyhow, she always thereafter claimed she was the first to receive a bow from the Emperor when he landed.

Young George, mounted on his pony and accompanied by his nurse, had watched and recalled something of the scene at Napoleon's funeral on 9 May 1821. That same month, aged 4½, he left his parents and began a voyage of 100 days to attend school in England. Fourteen or fifteen years later he returned to St Helena and was serving there at the time of the exhumation in 1840. He and his sister, Ellen, who died in 1916 and whom I remember as a very old lady, must have been the last survivors of those who had been at the funeral in 1821 (in her case, as an infant) and who were also on the island when the exhumation took place.

Ellen Bennett spent some sixty years of her life on St Helena, and some of her relations also lived there many years. Their good health and long lives do not support the suggestion often made that Napoleon was condemned to shorten his life in an unhealthy climate. St Helena is, in fact, quite healthy and also beautiful. But this is wandering from the little story of the exhumation and repatriation.

On 8 July 1840, HMS *Dolphin* reached the island to advise the Governor, Major-General Middlemore, that a frigate and corvette of the French Navy were under orders for St Helena to receive the body of Napoleon. They were preceded by two days by the French brigantine *Oreste. La Belle Poule* and *Favourite* arrived on 8 October. *Dolphin* remained until all the ceremonies were completed, so that four warships were anchored off Jamestown at the same time. The Prince de Joinville headed the French mission and was accompanied by Marshal Bertrand and others who had been with Napoleon at "Longwood".

Captain Alexander, RE, whom Bennett describes as CRE St Helena, was in charge of the exhumation. It had been arranged that the removal of the coffin (or, rather, coffins) to the frigate *La Belle Poule* should take place in the course of the day on 15 October, and that proceedings necessary for opening the tomb should not begin before midnight. Accordingly by midnight the Prince and the Governor, together with certain of their staffs, had assembled at the tomb, and Alexander's Sappers started their excavations. The covering stones had been laid in cement and the work occupied many hours.

The Governor had ordered that nobody was to be admitted to the vicinity of the grave without a permit from the Prince. A cordon of sentries had been posted right across Sane Valley, in which the grave was situated, to keep people off. Bennett, then aged 24 and a temporary Treasury clerk in the Commissariat, hadn't read orders and knew nothing about it. He started out early, alone and on foot, and reached Sane Valley about 10 am.

He says, "I was astonished to find the whole valley filled by fog of uncommon density, which had just come up from the sea. The edges of the fog bank were as clear and well defined as the walls of a house. When I had entered into it, I was effectually concealed. Following a footpath and knowing well the way, I walked on till I came out at the bottom of the fog bank. I had passed between the sentries, and I suppose they were not more than 50 ft apart. When I got out of the fog, I found myself just a few feet from the outer railings of the tomb. I was surprised to find myself the one solitary individual there; that is, outside the railings. There were two working parties of artillery and engineers inside the railings, about ten or a dozen men of each. These were the only persons visible. The officials of the exhumation mission had all retired to a large marquee, driven thereto I presume by the inclemency of the weather, for there had been much rain during the night. I can only account for the absence of Captain Alexander by the supposition that he had gone into the marquee with 'Eureka' on his lips."

He describes in a lot of detail the gear for lifting the coffin from the grave—"the apparatus used by the Royal Artillery in mounting and dismounting heavy guns"—but it seems to have been just a stout gyn. Something fairly strong was needed. The body had been encased in four coffins, including one of lead and two wooden ones. (In 1821, Sir Hudson Lowe had instructed Darling, the upholsterer for "Longwood" and who also made the coffins, to use his name to obtain all the help and materials he required. Bennett's father gave his mahogany dining table to contribute to the making of one of the wooden coffins.)

Napoleon's Tomb in Sane Valley, St Helena.

Napoleon's Tomb in Sane Valley, St Helena

When Bennett arrived, the men were working hard at the handles of a windlass, and very soon the bulky mass of coffin emerged from the grave. It was lowered on to the grass, and almost immediately the whole exhumation party appeared from the marquee and made straight for the spot. They then formed up, headed by the Abbé Cocquereau, and all moved back into the marquee where the coffins were opened and the contents verified. Bertrand, Las Cases and others who had been with Napoleon burst into tears when they again saw their Emperor's body. It was perfectly recognizable. Bennett, of course, witnessed nothing of this himself.

About four o'clock in the afternoon the procession from the tomb passed through Jamestown with the Militia band playing. One of the transport train wagons, covered all over with black cloth, bore the coffin. The four horses were similarly clad in black cloth trappings almost from their ears to their fetlocks. At the landing stage the frigate's boat was waiting, and as soon as the coffin was lowered into it the French band took up the music. Bennett says "The rain clouds had all dispersed and the afternoon turned out fine. Immediately the body was deposited on the deck of the frigate, all three ships were as by magic covered in flags. Then salvos were fired and, in the flames and smoke of what looked like a naval engagement, the sun went down. It was a wonderfully impressive sight."

In contrast to the solemnity and ceremonial of the big day, there had earlier been a lot of social events. A number of girls living on the island with their parents seem to have had a tremendous time, starting with the arrival of *Dolphin*. When the French ships arrived the tempo increased. The Prince de Joinville entertained generously on board the frigate, and there were dances on shore almost every evening. One of the girls, writing to a friend in England, says, "Marshal Bertrand often came to see us, also Las Cases, Marchand, the Commissioner Count Chabot (Ellen Bennett's beau), and many others." Ellen also danced with Emanuel Las Cases and Arthur Bertrand; but the latter "they all say was my beau", says the letter writer. The first lieutenant of the frigate was someone else's, and so on.

The same young lady volunteered to make two flags which she learned, probably through Captain Alexander, that the Prince wanted. She and five other girls, including Ellen, worked busily for three days to produce them. They were of Chinese silk with gold lace embroidery. One was unfurled at the stern of the frigate on departure. The other was for some purpose to do with the coffin, but not as the pall after the coffin was received on board.The Prince sent to thank her and presented her with a lovely bracelet which was clasped on her arm by his *aide-de-camp*.

The Prince also wanted some sprigs of willow, presumably from the trees planted by Napoleon at "Longwood", or from that growing at the tomb,[1] to present to his friends. Alexander got George Bennett, a keen botanist, to provide them, pressed and mounted on paper. He was delighted when Alexander later arranged that he should receive one of the commemorative medals struck by the French Government. Captain Alexander himself was

[1] On the north lawn in front of the Headquarters Building of the Royal School of Military Engineering, Chatham, there is a weeping willow guarded by an iron railing which bears a tablet inscribed, "This slip was taken from the Weeping Willow over Napoleon's Tomb at St Helena and presented to the SME by General Sir Reginald Hart, VC, KCB, KCVO".

General Hart was Commander Thames and Medway Defences and Commandant SME 1902–7, and Commander-in-Chief of the troops in South Africa from 1907 to 1914; the Island of St Helena was then in his military parish.

rewarded by the Prince for his various services with the gift of a gold snuff-box mounted with a miniature of his father, Louis Philipe, set around with diamonds.

Bennett describes going on board the frigate on the day after the exhumation. "An apartment was contrived in the hold to serve as a chapel for the performance of the religious rites. It was converted into a *chapelle ardente* immediately upon the reception of the body on board. It was a striking sight, the hangings and ornamentation being of a most costly and gorgeous kind. The pall was of purple velvet trimmed with ermine and with a large gold eagle in each corner. Candles in countless numbers were there. There was an altar at which the Abbé Cocquereau was officiating in splendid vestments. I believe the services were continued without intermission by him and his assistants until the arrival in France."

HMS *Northumberland* with Napoleon on board had anchored at St Helena on 15 October 1815. That same day exactly twenty-five years later his body lay in one of France's warships.

Correspondence

Major R. A. Linton, AMIEE, RE (retd)
Turret House Lodge,
7 Limmer Lane, Felpham,
Bognor Regis,
Sussex.
1 February 1963.

The Editor,
The RE Journal.

Dear Sir,

I hope Brigadier Lavies will forgive my quoting a sentence from his letter of 26 October 1962. He writes:—

"Whatever shortcomings there may be can only properly be measured against what we hope to achieve and this should show us what improvements are needed."

Surely we can only decide what improvements are needed by studying the shortcomings of today, and we can only assess Brigadier Lavies' hope of achieving an improvement by considering the policies which he recommends.

As I understand it he considers that in future a few more Long Course graduates may reach Lieut-Colonel in general duties, but that the number required for technical responsibilities will not alter.

I do not think that any technically qualified officer would regard this as much of an improvement, for the point which I and others have made is that a professional engineer needs to practise his trade in order to remain competent.

I would go further than Major Horne and question the ability of Long Course graduates many of whom have never carried responsibility in any major engineering job, let alone the requisite three years experience which the major professional institutions require. These officers cannot be regarded as competent engineers unless they have practised their profession successfully over a period of years.

Major Horne's ironic suggestion that Sapper officers should stop masquerading as engineers illustrates the trend, and Captain Arnold's letter exposes the dissatisfaction of both officers and tradesmen alike at this trend.

In war time the Corps is required to build roads, docks, permanent bridges, depots etc., and to organize the supply of materials for them. A very high order of engineering ability is required for the efficient discharge of these responsibilities. All RE officers should have some experience of such work, and a nucleus should be experienced in the many complex engineering problems which area responsibility entails.

Field engineering and staff work no doubt have their place, but an engineer officer is expected to be first and foremost a competent engineer. As Captain Arnold rightly points out the only way of maintaining such competence is to employ whole formations on major engineering projects in peace time.

The Americans have long recognized the necessity of this and their responsibility for American riverworks provides them with this experience.

If the RAMC were not able to practise medicine in peacetime they would be incompetent in war, and if the RAF could not fly aircraft in peacetime, how could they maintain their skill? What I am saying is that the policies at present being followed are rendering the Corps incompetent to meet the engineering challenge of war.

I repeat my suggestion that the Corps should seek a peacetime responsibility for construction work at ports, harbours and on sea defences. There is enough work in West Sussex alone to keep them busy for several years.

Yours faithfully,
R. A. LINTON.

Major G. Horne, AMICE, RE (retd)
Ditchling, Sussex.
12 February 1963.

The Editor
The RE Journal.

Dear Sir,

THE OPPORTUNITIES FOR "CIVIL ENGINEERS" IN THE CORPS

Colonel Cartwright Taylor's article on "The opportunities for Civil Engineering Graduates in the Army" has sparked off two basic criticisms of the present-day Corps. Firstly that of Major Linton, ably supported by Captain Arnold, concerning the lack of real engineering experience, at various levels, obtained in the Corps. Secondly my own criticism, which is shared by a considerable number of officers, that as things are at present there is absolutely no future for trained engineers as opposed to trained Staff officers, and the Corps should be "honest" enough to admit this.

The speed with which "authority" has replied shows that "sore points" have been touched, but the replies tend to confirm rather than confute both criticisms.

The "projects" quoted in the September *Journal* as providing good engineering experience are not only ones which, as pointed out by Captain Arnold, do not need fully qualified engineers, but they are also "projects" which have, on the whole, been completed. It would be more to the point if a list were published showing engineering (not building) works which the Corps is undertaking now or which are planned for the near future. As for the list of "officer attachments" (where contractors are doing the engineering, not the Corps) one cannot help but feel that the officers concerned would be helping their careers much more by studying for Staff College as the Corps will have little use for them as qualified civil engineers.

The American Corps of Engineers (and no doubt the Russians also) carry out a great deal of "real" engineering both as consultants and contractors. It has always been said that in this country the unions would not permit such a practice, although I fail to see how they can object to our acting as consultants, but I doubt if any really serious attempt has ever been made to overcome the "supposed" objection or if the

Corps has ever studied how the Americans have achieved such a marked superiority in obtaining engineering experience. The fact that no "Long Course" officers ever seem to go on the visits to the States tends to confirm my last doubt.

We have indeed failed miserably to carry on the tradition of forebears such as Baker, Fife, Browne, Dyas, Hearn, Jacob, Pennycuick and Taylor to name just a few.

Brigadier Lavies' letter, in answer to my original criticism, raises a number of points to which I should like to reply in detail:—

Although he (Major Horne) has based his arguments on fact he has drawn most misleading conclusions.

The Brigadier's case is based purely on promises and he admits that it is only Senior Captains downwards who have "engineering prospects"; thus "engineer" trained Majors from my vintage to the present day (an age range of nine years) are admittedly consigned mainly to the "scrap heap".

May I quote two previous "promises":—

(*a*) "The structure of each Arm and Corps has been so designed as to give good prospects of promotion once the run-down has been completed".

(This is stated War Office policy, but they omit to say that it hardly applies to anyone who is not *psc*.)

(*b*) "For an officer who is otherwise qualified for command, the attainment of professional status at the level of an Associate Member of the Institution of Civil Engineers will be to his advantage in considering his selection for certain senior staff and regimental appointments in the Royal Engineers".

(E-in-Cs Memorandum 43/SME/1946/(E Trg) dated 24 July 1962, "exhorting" officers to go on Long Courses).

The result of these past "promises" is the distribution of Lieut-Colonels shown in the table at the end of this letter. Why should the present "promise" prove any different to the previous ones?

Forecast based on psc or other qualifications borne by those who are now Lieut-Colonels or Colonels is seriously misleading, because a large proportion were nominated to attend short War Staff Courses.

This is probably true as far as Colonels and above are concerned, but in my first letter I made no comment regarding "Red Hat" postings as I considered that, on the whole, they had cleared the "Lieut-Colonel hurdle" prior to redundancy added to which, owing to the war, most of their generation had not the opportunity to attend Long Courses whereas they could attend a Staff Course. However, a glance at the table at the end of this letter, will show that this "bracket" has, in fact, made itself very much an exclusive "*psc* club".

As far as Lieut-Colonels are concerned the comment regarding War Staff Courses seems rather pointless as "War time" or "Post war" *psc* has pushed out "C", also I am of the opinion that the bulk of present Lieut-Colonels attended post-war Camberley.

Many who would have appeared as "Works" (I would have preferred "C") or E & M qualified Lieut-Colonels have left the Service on redundancy.

A rather strange statement this as the Corps is unable, or unwilling, to find suitable employment for those who did remain (the whole point of my argument in fact). Had a greater number of "non-*psc*" officers stayed on the position would be very much worse and, in fact, they would have been "detailed" for redundancy.

It is true that the theoretical prospects of the outstanding Staff College graduate may be Field Marshal and that of the Long Course graduate only Major-General (two recent Engineers-in-Chief were not psc) . . .

This is a well used "red herring" and brings little comfort to efficient and experienced officers whose careers have been cut short as Majors or who, with luck, see their absolute ceilings as Lieut-Colonels. Even the fact that two recent Engineers-in-Chief were not *psc* is not very encouraging if one studies the present list of Senior Officers. In fact I would suggest that as the Corps is becoming primarily a "Staff Corps" in the higher ranks all future Engineers-in-Chief must be *psc*.

No RE Officer should expect to serve his whole career in one line of employment.

Although this is slightly irrelevant to the argument, no one would disagree. However, it appears strange that whereas Staff trained officers are eligible for senior "ESSE" posts no Long Course Officers go to senior Staff postings. Even a present NATO post in Naples, which is very much "Engineer Planning" is filled by a staff trained officer, not a Civil engineer. Perhaps if a Long Course officer were posted to AG7 or MS the balance might become a little more realistic.

. . . *High non-technical posts also open to Long Course graduates.* . . .

Such a post has yet to be filled by a Long Course graduate who is not *psc* (not including Tn and Svy) and, as things are at present, I doubt whether it ever will be

Competitive performance is always a factor . . . a Long Course may well provide much needed security. . . .

The so-called "competition" is completely and utterly weighted in favour of *psc* whilst if a Long Course is only to be considered as "Insurance" and not as a stepping-stone in the Corps, why not say so instead of trying to pretend otherwise?

The old Civil Engineer School has not disappeared. It has been reorganized and its functions remain unchanged except in name.

The obvious comment to this remark is, of course, why change its name?

Actually I would suggest that its main function has changed as there was a time when it was considered necessary to have in the Corps a number of senior officers who through their qualifications and experience could "talk the same language as the civil engineer"; the need for such officers having become very apparent during the last war.

The Civil Engineer School was the obvious "cradle" for such officers, but now they are apparently not required.

Because he finds grounds for present dissatisfaction Major Horne concludes that we should forsake the principles so clearly set forth by the Engineer-in-Chief in "Signpost for Royal Engineers" . . .

Whether I am "dissatisfied" or not is completely irrelevant as it is the Corps, not my career, that is under discussion.

It is obvious that the main point of my criticism has been misunderstood as I am not advocating forsaking any "principles". I am merely saying that we should practice what we preach. If the Corps is not offering its civil engineers a future, as it is not, then be honest and admit the fact. If, however, there is supposed to be a future for them, then sufficient senior postings should be made available.

Having re-read the Engineer-in-Chief's article it is more horrifying than ever to consider the great amount of "engineer experience" that has been lost to the Corps over the last two or three years. May I quote a comment made by a Senior, and very "staff trained", officer in this respect.

"Personally I think that the whole Corps should be most perturbed when a Long Course Officer decides to retire, long before his time, but they are not. . . ."

The only thing that does appear to "perturb" the Corps upon such a retirement is whether the officer concerned is taking up employment with a firm with whom he has dealt "officially" during the last two years of his service!

Finally, I should like to repeat the distribution of Lieut-Colonels, and full Colonels and above, to save any interested reader having to turn back to the December *Journal*, also it does illustrate a number of my points. For those who say that there are now 12.2 per cent of the temporary Lieut-Colonels qualified engineers as opposed to 4.7 per cent in the substantive rank I would remind readers that civil engineering should be the main qualification (next to being a regimental soldier) of any Military Engineer and point out that to have no qualification at all appears to give one an equal, or slightly better, prospect of promotion in the Corps of Royal Engineers than being a qualified engineer.

Yours faithfully,

G. HORNE.

DISTRIBUTION OF SENIOR RANKS
TAKEN FROM THE *RE LIST* FOR NOVEMBER 1962

Qualification	General Officers	Brigadiers	Colonels	Lieut-Colonels	T/Lieut-Colonels
(Total)	8	19	48	107	41
Staff trained	7	16	40	77	20
No of staff trained with technical qualifications	(2)*	(2)*	(6)*	(10)	(2)
Svy	1	3	3	9	7
Tn	—	—	2	5 (1 with "C")	1
Technical qualifications only	—	—	3	—	—
ptsc	—	—	—	4	1 (Also EM)
EM	—	—	—	2	1
C	—	—	—	1	3
AMICE and C	—	—	—	4	2
NIL	—	—	—	5	6

* *Interesting figures for a technical Corps.*

Brigadier Sir Mark Henniker, Bart, CBE, DSO, MC.
Pistyll, Began Road,
St Mellons, near Cardiff.
15 February 1963.

The Editor,
RE Journal.

Dear Sir,

Major Horne makes a constructive suggestion in saying that attachments to civil firms might be restricted to Staff-trained officers. Brigadier Lavies ducks this one,

There is only one quality whose absence will debar an officer from getting to the very top: that is the ability to win battles. This is the supreme quality. The ability to design structures comes somewhat lower. In civil life there is a parallel. The supreme quality is the ability to make money. If you can do that, you can always hire some damn fool who can solve differential equations.

At quite an early stage in an officer's career you can tell if he is the sort who *might* be able to win battles. (You can't be *sure* until he has actually done so.) The sort who *might* be battle winners generally find their way to the Staff College. Short of warfare there are then only two forms of training the Army can offer—command, which by hypothesis only a few at each rank can exercise; and Staff employment, which teaches an officer to make the machine work. Is not civil engineering a third way of training the potential general?

The civil engineer is up against many of the same factors as the soldier; men, weather, equipment and so on. But the only man who is really up against these thing is the boss. It is he who loses his money if he makes a mess of it. It is, therefore, essential that if civil engineering attachments are to help an officer to develop as a top flight man, he must taste the responsibility that really makes his bones creak. That is the difficult thing to arrange.

The only way that I can see whereby Sappers can have this supreme responsibility is by the War Office assuming responsibility for some side of civil engineering in peace time: so that Sappers can be put in at the top as well as below. And the men to put in at the top are the Staff trained ones, because they are the potential battle winners.

The trouble with Works Services latterly was that sufficient authority was not delegated. Few major works ever began in under a year of their inception. In this time the CRE or the CE could consult everyone in the world, and could really only make a mistake if he were both supid and obstinate—as many of us were! The kind of work Sappers ought to be responsible for is something like sea shore defences, river catchment work etc, where nature will knock the man over if he does not act quickly and rightly.

The lower echelons of such work will surely provide the genuine engineer (ie the man who prefers engineering to purely military work) with something to get his teeth into as well.

It all comes back to the same old thing. In the last century and in wartime, Works Services really gave the Sapper responsibility, and many great men emerged. Today there is no Works Services; and field engineering only teaches officers how to make men (who don't want to) fill sandbags in the dark—a very useful attribute but not a supreme one. The odd job in Jamaica or Christmas Island is far too haphazard in whom it embraces. A regular service calling for engineer skills is needed; and to this should be posted the officers who will benefit from it, many of them being Staff trained for work at the top.

Yours sincerely,
(Signed) M. C. A. HENNIKER.

Major-General T. H. F. Foulkes, CB, OBE.
Engineer-in-Chief,
The War Office,
Whitehall, SW1.
15 April 1963.

The Editor,
RE Journal.

Dear Sir,

I have read the whole of this correspondence with the greatest interest and am very grateful to the contributors for all the time and trouble they have taken to express their views and help me in my duties, though these views are inevitably written from a particular standpoint and without full knowledge of the facts of manpower, finance and Whitehall policies, or of the national strategic concepts which the Corps exists to support.

No one is more conscious than myself of the need for a proper *balance* between the overall military and technical functions of the Corps. In the past, our Works commitments have been out of proportion to our limited resources. The de-militarization of Works reversed the situation, and I have always been fully aware of the reduction of responsibility and promotion prospects that this has caused. The continuous policy of the Corps is to improve the balance and I see no reason to doubt that it will be successful. The modern Army simply cannot do without a good all-round Corps of RE and this includes good engineers who must be properly trained.

Comparisons between the United States Corps of Engineers and ourselves are invalid. They are predominantly a Service whose huge engineering responsibilities derive from the geographical, historical and political facts of their own country. We are predominantly an Arm and it is idle to suppose that many of our officers will go very far in the Army without possessing pronounced military qualities. All the same we offer much to all, and our future prospects of promotion are excellent.

I cannot dwell on the other misconceptions that have appeared in this correspondence, but readers of the *Journal* should realize that a spate of water is flowing under our bridges, that much engineering is being done by the Corps, world-wide, and much is being learnt by individual officers and many qualifications earned.

Interesting as Major Horne's statistics will be to some readers, I attach far more importance to such considerations as I have mentioned above; and statistics in themselves can never be of great value unless they make direct comparisons between like and like.

Yours faithfully,
T. H. F. FOULKES,
Major-General.

This correspondence must now cease.—EDITOR.

The Editor
The Royal Engineers Journal
Chatham.

18 Cranmer Court,
London, S.W.3.
11 March 1963.

Dear Sir,

To the article "Farewell to Troopships" in your March issue may I add one small footnote for the historical record.

In the Port of Southampton, used so much by the troopships, they were always known as "the margarine ships" because a well-known brand of this commodity was wrapped in paper decorated with a broad band of dark blue—similar to the band on the vessels.

Yours faithfully,
GILBERT S. SZLUMPER (*Hon Major-General*)
Manager of Southampton Docks 1919–1925

Editor
The Royal Engineers Journal
The Institution of Royal Engineers
Chatham.

Captain's Hill,
Leixlip,
Co. Kildare, Ireland
13 March 1963.

Dear Sir,

"CHIEF ENGINEER AT GETTYSBURG"

I referred to my nephew, Mr Martin Tierney, Barrister-at-Law, who has made some study of the American Civil War, the article which appeared under the above heading in your March number. Like myself, he considers it admirable as far as it goes, but points out that its tribute to Brigadier-General Gouverneur Kemble Warren is imcomplete.

On the day following the timely intervention by which he prevented seizure of Little Round Top by the Confederates, that is to say on the second day of the battle, he again took an initiative which had a most important if not decisive influence on the outcome. A counter-cannonade was going on between the Confederate artillery on Seminary Ridge and the Union artillery on Cemetery Ridge. Warren, who was again at Little Round Top, anticipated just such an assault as Pickett's charge and realized that the smoke with which the ground between the two ridges was being filled would much help such an attack. As a result of a message from him, the Union artillery stopped firing, with a double advantage to the Union forces. The Confederate artillery were deceived into thinking that the Union artillery had been silenced by them and also stopped firing, thus not only helping to lift the smoke screen but leaving the Union with surprise fire power and in a less harrassed position to meet the assault, without which advantages on their (the Union) side, Pickett's gallant charge would almost certainly have been successful and quite possibly decisive.

Yours faithfully,
NIALL MACNEILL, *Colonel*
Reserve of Officers & Corps of Engineers, Irish Army.

The Editor,
Royal Engineers Journal

Staddlestones,
South Farnborough,
Hants.
30 April 1963

Dear Sir,

"CHEAP MOBILITY"

With reference to Lieut-Colonel Sandes' very interesting article on Cyclists troops in the *Journal* for March, I would like to correct his statement that there were *no* cyclist units in our Army in 1935. In fact there were two experimental cyclists units. Furthermore they were RE units namely the 12th Fd Coy and the 5th Fd Coy. I was serving in the former. The men rode bicycles and the tools and equipment were carried in, I think, eight lorries. Officers were mounted in Austin Sevens. There were also m/c despatch riders, five I believe in number.

Our experiences may be of interest. The advantages were many and not necessarily inapplicable in these days of road congestion. Mobility after rigorous training in cycling was astonishing and particularly in what one might call penetrative mobility. There was no difficulty in covering 70 miles in the day and even after this the men were absolutely fresh for work. There was not the slightest difficulty in passing through congested columns of transport, gunners, etc. An example of this was the great manoeuvres of 1935. I believe the biggest held in the UK in peacetime. Before the start there was a most severe storm so much so that the exercises were postponed for 48 hours. A report came in that our camp 15 miles away had been blown down. Consequently I took the Company away from our concentration area for rescue operations. About 1300 hrs I heard the authorities had changed their mind and the exercise was to start forthwith. After tidying up we left about 1530 hrs and penetrating through the columns of transport and marching units, etc, we were back in our proper place in the march table without anyone being aware of our unauthorized absence.

Cyclist troops take up a great deal of road space. One advantage from this is that owing to the length of the column a cyclist unit of Fd Coy strength can hardly be ambushed or surprised. Their mounts are almost invulnerable, and easily concealed as Colonel Sandes states. There are no "horseholders", i.e. full firepower can be developed in action. Our Force Commander in 1935, Sir Francis Gathorne Hardy was quick to realize this mobility and invulnerability. Eventually we were responsible for the whole protection of the northern flank of the force, which we maintained by strong two-hourly snake patrols à la Cavalry. We never had the slightest fears that these would be penetrated without adequate warning by any arm including tanks. We considered that our range of action in such military affairs was roughly double that of cavalry in range and in speed and in self protection.

I believe I am correct in saying that the BEF in 1914 seized the Aisne crossings by the Divisional cyclist units and held them successfully until relieved. There is no question that the use of bicycles in guerilla warfare has been universal.

As regards training and equipment, vigorous training in cycling and cyclist drill is absolutely essential, we found. A cyclist unit is definitely not acquired by mounting riders on bicycles. It was also found about 5 per cent of otherwise apparently fit men were basically incapable of cycling efficiently or with the requisite stamina. They just could *not* keep up with the rest however much training they received. Cross country performance in practically all types of country is far greater than one anticipated. There were no fodder or major petrol problems. We found contrary to expectation that the GS bicycle, despite its weight, and perhaps its backpedalling brake, was more serviceable than the collection of ordinary civilian bicycles we had issued for test.

Under modern conditions of atomic war dispersion, there is probably a role for some specialist fighting cyclist units using their mobility and unobtrusiveness to avoid atomic strikes, to seize focal points by surprise, etc. But I stress again ample training as cyclists and as cyclist troops is essential to achieve notable results.

Yours faithfully,
A. F. Toogood, Lieut-Colonel, RE (Retd)

General Sir Cecil Sugden GBE KCB
Colonel Commandant RE and RAOC

Memoirs

GENERAL SIR CECIL SUGDEN, GBE, KCB
COLONEL COMMANDANT RE and RAOC

CECIL STANWAY SUGDEN (generally known in the Corps as Cuthbert Sugden) was born in Rawal Pindi on 4 December 1903, the younger son of Captain and Mrs A. Sugden of Tankerton, Kent. He was educated at Brighton College and the RMA Woolwich, and commissioned into the Royal Engineers on 29 August 1923, being twelfth in his large batch of thirty Young Officers.

After passing his YO Courses at Chatham he was posted to 5 Field Company at Aldershot, but shortly afterwards he returned to Chatham to become a Party Officer in the Training Battalion RE where he remained for three years; at that particular time every Party Officer was a most outstanding and carefully selected subaltern.

In 1929 he gained Works experience as Assistant Engineer, Portsea under the DCRE Portsmouth, before being posted to India the following year. During his tour of duty in India he served almost continuously with 13 Field Company QVO Madras Sappers and Miners with a short spell as Assistant Adjutant of the Madras Sapper and Miners Corps. In 1936 he returned once again to 5 Field Company at Aldershot, but, having qualified by competitive selection for the Staff College, he returned to India in 1937 to become a student at the Staff College, Quetta. On the completion of the Staff course he was posted as a GSO3 in the Military Operations Branch, the War Office, a most coveted appointment.

On the outbreak of war in September 1939 he became a GSO2 and in January 1941 he was promoted to become GSO1 in the Military Operations Branch. In 1942 he flew to North Africa to become Brigadier General Staff (Operations and Plans) at Allied Forces Headquarters, Algiers. A year later he returned to the War Office to become Director of Plans, and in February 1945 he became Director of Military Operations with the rank of Major-General. He was a member of the British delegation to the Yalta Conference and remained Director of Military Operations until the end of the war.

In 1947 he attended the Imperial Defence College as a student and his next appointment was that of Chief of Staff, British Troops in Egypt. Towards the end of 1949 he became Director of Personnel Administration at the War Office, and after two years he went to Germany as Chief of Staff Northern Army Group. In May 1954 he succeeded Sir Terrence Airey as Commander Land Forces, Hong Kong. In August 1954 he was promoted Lieut-General and took over from Sir Robert Mansergh as Commander-in-Chief Allied Forces Northern Europe. In 1958 he was promoted General and became an Army Councillor when he succeeded General Sir Nevil Brownjohn, GBE, KCB, CMG, MC, ADC, Colonel Commandant RE, as Quartermaster-General to the Forces. He retired from the Active List in 1961, but early in 1962 he succeeded Lieut-General Sir John Cowley, KBE, CB, Colonel Commandant RE, as Master General of the Ordnance and retained his Membership of the Army Council in a civilian capacity. In that post he was responsible for the design and production of Army weapons and equipment in the important period of transition to a small all-regular force. Early this year he resigned his appointment as Master General of the Ordnance on the grounds of ill health (the appointment being filled by another Sapper officer

Lieut-General Sir Charles Jones, KCB, CBE, MC, Colonel Commandant RE). He died in Queen Alexandra's Military Hospital, Millbank, London on 25 March 1963, aged 59 years.

He was awarded the OBE in 1940, the CBE in 1944, the CB in 1946 and became KCB in 1955, and GBE in 1960. In 1942 he was made an Officer of the Legion of Merit (USA). He became an ADC General to the Queen in 1960. He was made a Colonel Commandant RE on 4 May 1960 and Colonel Commandant RAOC on 10 June 1962.

On 6 February 1934 he married Diana Primrose, only daughter of General Sir Richard Ford, KCB, CBE, Royal Marines (retired) at Holy Trinity Church, Folkestone. They had two daughters.

Sir Richard Way, Permanent Under Secretary of State, The War Office paid the following tribute to General Sugden in *The Times* which is reprinted by permission.

"Your obituary notice of General Sir Cecil Sugden referred to his outstanding ability as a Staff Officer, but it did not indicate quite how brilliant he was in this sphere. I should like, as a civilian colleague of his for over twelve years and one who has been very closely associated with him during the past three, to write a few words about him.

In many years association with the Army I have never worked with a more able staff officer. It seemed natural, when one was faced with a difficult problem, to wonder what his view on it would be, and forthwith to seek it. This was true, irrespective of whether the question involved was strictly within his field of responsibility. He had the great gift of balanced judgment which comes from intellect, intelligence and common sense. I know of no-one whose views on most problems were valued more than his.

As a man he had a personality which was quiet but strong and it was possible on a superficial acquaintance to regard him as reserved and slightly unforthcoming. This impression was invariably dispelled on further acquaintance when he was revealed as one of the kindest and most congenial of colleagues and friends. I have never met anyone who knew him well who did not respect him greatly both officially and personally.

At a Memorial Service, held on 18 April 1963, at Holy Trinity, Brompton, the Queen was represented by the Chief of the Imperial General Staff, General Sir Richard Hull. Prebendary P. N. Gilliatt officiated and the Chief Royal Engineer, General Sir Frank Simpson, read the lesson. Amongst those present were:—

Mr and Mrs R. G. L. Lushington (son-in-law and daughter), Miss Alexandra Sugden (daughter), Group Captain Richard Ford (brother-in-law), Mr and Mrs G. L. Pears.

Lieut-Colonel Thorvald Randers (Army and Air Attaché, Norwegian Embassy, representing the Norwegian Government, the Norwegian Army, the Norwegian Ministry of Defence and the defence staff); Mr John Profumo, MP (Secretary of State for War) and Mrs Profumo, with General Sir Richard Goodbody (Adjutant General), General Sir Gerald Lathbury (Quarter-Master-General to the Forces), Lieut-General Sir John Hackett (Deputy CIGS) with Lady Hackett, and Mr R. H. Melville (also representing the Permanent Under Secretary of State for War); Lady (Frank) Simpson, Lieut-General Sir Charles Richardson (representing Northern Command), General Sir Nevil Brownjohn, General Sir James Steele (president, Army Benevolent Fund), General Sir Robert Mansergh (Master Gunner St. James's Park, representing Royal Regiment of Artillery), Major-General Sir Leslie Tyler (representing The Royal Electrical and Mechanical Engineers), Lieut-General Sir John Anderson, General Sir Geoffrey Bourne, Lieut-General Sir John Cowley, Lady McLeod; Judge Sir Alun Pugh (chairman of governors, Brighton College) with the headmaster and Mrs W. Stewart and the chaplain; Mr John H. Tratt (also representing Association of Old Brightonians), Major-General T. H. F. Foulkes (Engineer-in-Chief) and Mrs Foulkes, Major-General A. H. Dowson (Director-General, Military Staff for Ordnance Survey), Major-General A. J. H. Dove (chairman. Royal Engineers' Association), Brigadier J. M. L. Gavin (Chief Engineer, Eastern Command), Brigadier T. H. Evill (Chief Engineer, Northern Command, also representing the GOC-in C, Northern Command, Master General of Ordnance-designate), Brigadier K. F. Daniell (Chief Engineer, Western Command, also representing the GOC-in-C, Western Command), Colonel R. A. P. Wehner (Deputy Commandant, Transportation Centre, RE), Major-General H. J. C. Hildreth (Director of Ordnance Services, War Office), Major-General C. H. McVittie, Brigadier R. E. Moss (RAOC Training Centre), Brigadier G. Le F. Payne, Brigadier J. Sheffield and Brigadier C. Hunt (representing RAOC Association), Major-General H. M. Liardet (representing the Master General of the Ordnance Department, War Office) and Mrs. Liardet with Major-General A. P. W. Hope: Major-General R. J. Moberly (Retd) (Colonel Commandant, Royal Signals, representing Royal Corps of Signals, and Director of Communication and Electronic Equipment under the MGO), Major-General E. S. Lindsay (Assistant

Master-General of the Ordnance, War Office), Major-General C. T. D. Lindsay (Director-General of Artillery, War Office), Brigadier L. J. Harris (Director Military Survey, War Office and Air Ministry), Brigadier F. S. R. Mackenzie (representing Director, Fighting Vehicles Research and Development Establishment), Mr E. W. Chivers (Director, Royal Armament Research Development Establishment), Colonel R. L. France (Assistant Director, representing the Director, Royal Engineer Equipment), Captain A. J. Symons (representing Institution of Royal Engineers), Major-General B. D. Jones (representing Colonel Commandant, RAOC).

Major J. P. K. Crawford (representing the Commandant, Royal Military College of Science), Colonel J. A. Cameron (representing Madras Sapper Officers' Association), Lieut-Colonel J. W. P. Saunders and Mr S. N. Russell (representing British Aircraft Corporation), Colonel H. Lacy (representing Vickers Ltd), Major-General D. J. Wilson-Haffenden, Major-General J. M. Kirkman, Major-General B. K. Young, Major-General W. M. Hutton, Major-General John Dalton, Major-General Llewellyn Brown, Major-General Thomas Churchill, Major-General A. E. Campbell, Major-General C. R. Price, Major-General and Mrs J. F. D. Steedman, Major-General E. C. Colville, Major-General R. T. Ransome, Major-General J. H. Amers, Major-General J. R. C. Hamilton, Brigadier and Mrs R. H. Keenlyside, Captain T. M. Brownrigg, RN (Retd), Colonel A. M. Field, Major I. B. Baillie (representing Field Marshal Lord Harding of Petherton), Major K. L. Todd, Mr T. A. G. Charlton, Mr R. K. Dickson, Mrs Malcolm Sandman, Mr J. E. Jackson, Mr S. Shaw, Mrs E. Loraine, Mr and Mrs Robin Gordon, Mr J. Parkin, and Dr W. B. Littler.

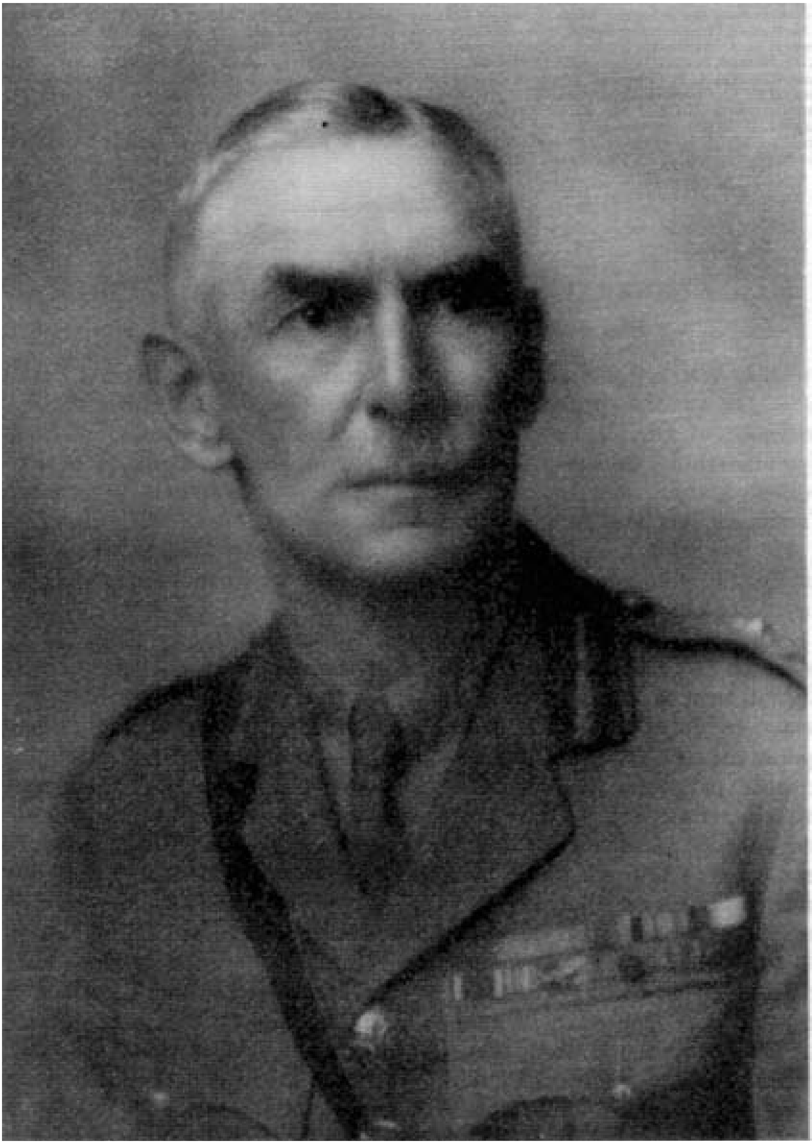
MAJOR-GENERAL SIR CHARLES GWYNN, KCB, CMG, DSO

Past President Institution of Royal Engineers

Charles William Gwynn was born at Ramilton, Co Donegal on 4 February 1870. He was the third son of the Rev John Gwynn DD, sometime Regius Professor of Divinity at Trinity College, Dublin and brother of Stephen Gwynn, scholar and writer, Dr E. J. Gwynn, former President of Trinity College Dublin, and the Rev R. M. Gwynn for over fifty years tutor of Trinity College and John Tudor Gwynn, the writer on Indian affairs.

He was educated at St Columba's College, Rathfarnham, Dublin and at the Royal Military Academy, Woolwich. He was commissioned into the Royal Engineers on 15 February 1889.

After completing his courses at the School of Military Engineering he remained at Chatham first as a Company Officer with N (Depot) Company RE and then as Assistant Adjutant for Musketry. In November 1892 he was posted to Sierra Leone and during the following two years he took part in operations against the Sofas as Intelligence Officer and, as guide to the advance party, he was responsible for preventing the force straying into French territory. He was wounded three times, was mentioned in despatches and awarded the DSO. He was also recommended for a brevet majority on promotion to Captain which he achieved in February 1900. In 1894 he was invalided home due to wounds and spent a short while with a balloon detachment at Aldershot. He returned to Sierra Leone to become CRE in November 1894 and he held that appointment until being posted to the Office of Inspector General of Fortifications at the War Office where he stayed for a year. A short spell of regimental duty at Chatham as Assistant Adjutant of the Service Battalion, SME then followed, and in April 1897, although not staff trained, he was specially selected to work in the geographical section of the Intelligence Branch at the War Office under Major-General Sir John Ardagh, KCMG, KCIE, CB, the then Director of Military Intelligence. Sir John was a graduate of Trinity College Dublin who entered the Corps in 1859. Before becoming Director of Military Intelligence he had been Commandant of the SME where he had been highly impressed by Gwynn's outstanding ability. Two years later Gwymn's duties took him to Egypt where the reconquest of the Sudan by Kitchener had made necessary much survey work. He was employed on delimiting the Sudan-Abyssinian wild and mountainous frontier and took part in many political negotiations connected with that difficult task. For his services he was awarded the CMG in 1903.



Major-General Sir Charles Gwynn KCB CMG DSO

In September 1904 he returned home and, after a short period in a Works appointment in the Isle of Wight, he became a student at the Staff College, Camberley. After graduating from the Staff College he was sent to the London School of Economics for a year's course. In 1908 he was seconded to the Colonial Office and was appointed Commissioner of the Abyssinian-East African Boundary Commission and his work on that Commission earned him the award of the Peake Fund Medal by the Royal Geographical Society.

After a short period as Staff Officer to the Chief Engineer Irish Command Gwynn was sent to Australia in 1911 where he was employed, with the local rank of Lieut-Colonel, as Director of Military Art at the newly established Royal Military College, Duntroon. During his first year there he was the Acting Commandant and, as such, he had a good deal of responsibility for arranging the curriculum and also for setting the tone of the College and the establishment of good relations with the British Services. He was still at Duntroon when the outbreak of the First World War in August 1914 caused a dispersal of the college and Gwynn returned home.

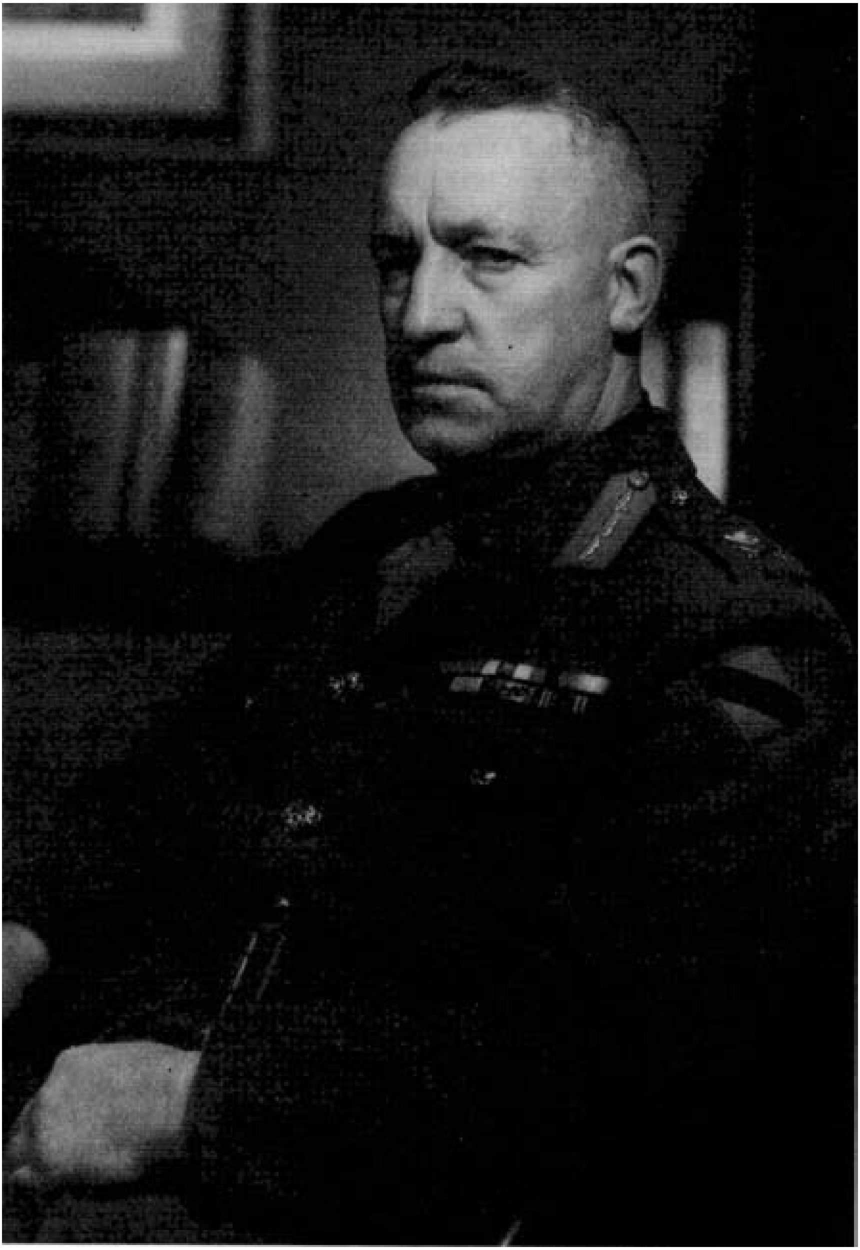
He spent the first year of the war as GSOI 57th (West Lancashire) Division, a second line Territorial formation employed on Home Defence. In July 1915, however, he joined the staff of the 2nd Australian Division then forming part of the Mediterranean Expeditionary Force and training in Egypt. He accompanied the Division to Gallipoli and was soon given command of the 6th Australian Brigade. When the Australian and New Zealand Forces were reorganized and expanded he was appointed Brigadier-General General Staff II Anzac Corps (later to become XXII Corps). He served in that capacity when his Corps was transferred to the Western Front and took part in the Battles of Messines, "Third Ypres" and Mount Kemmel and in the final Advance to Victory. In 1918 he was created CB.

From March to September 1919 he commanded an infantry brigade of the British Rhine Army. He was then brought back home to become GSOI of the 1st Division at Aldershot, and after six months in that appointment he became Brigadier-General on the General Staff of Headquarters Eastern Command. He was made ADC to the King in 1923.

Promotion to Major-General came in 1925 and in May 1926 he was appointed Commandant of the Staff College, Camberley. It was a difficult time for forward thinkers due to the Government policy of retrenchment and the limitation of armaments and lack of their development imposed by financial restrictions. Nevertheless during his tenure as Commandant Major-General Gwynn had on his staff in GSOI appointments Finlayson, Squires and Wilson and in GSOII appointments Brooke, Montgomery, Lindsell, Paget, Leigh Mallory (RAF), Grassett and Morris (both RE), Pownall, Eastwood and Gifford—a pretty hot team. Among the students were Alexander, McCreery, Gott, Dempsey, Ritchie, Oliver Leese, Brian Robertson (RE) and Harris (RAF) a no less about-to-be famous collection of outstanding officers. General Gwynn's tour as Commandant was extended by a year beyond the normal. He was promoted KCB and he retired, at his own request, on 8 January 1931.

From 1938 to 1941 he was President of the Institution of Royal Engineers. During his younger days he was an outstanding games player, and he must rank among the very few who have represented the Corps at Cricket, at both Rugby and Association Football and at Golf.

After his retirement he wrote at the request of General Sir Hugh Elles,



Major-General Guy Roderick Turner CB MC DCM CD

KCB, KCMG, KCVO, DSO, Colonel Commandant RE, at that time Director of Military Training, a book entitled *Imperial Policing*. He also wrote on military subjects in *The Times*, the *Telegraph* and the *Morning Post* and for various war publications of the Amalgamated Press. He was also the Military Editor of the nine volumes of *The Second World War*, edited by Sir J. Hammerton and published by the Amalgamated Press.

In 1904, he married Mary, widow of Lieutenant Lowry Armstrong, Royal Navy. She died in 1951. They had no children.

He died at the age of 93 years in Dublin on 12 February 1963.

MAJOR-GENERAL GUY RODERICK TURNER, CB, MC, DCM, CD

Guy Turner was born on 13 December 1889, at Four Falls, New Brunswick, Canada, and had his schooling and early training in that Province. He qualified as a Junior Member of the Engineering Institute of Canada in1914, becoming a full Member in 1940. He died suddenly at Ottawa on 22 February 1963 and was buried at Fredericton, New Brunswick.

His military career started in 1906, when he joined the ranks of the 67th (Carleton) Regiment, NPAM. On the outbreak of war in 1914 he joined the Canadian Engineers, of the Canadian Expeditionary Force, as a Sapper, becoming a Sergeant in the 3rd (Field) Company, CE, within a fortnight. He was in France with this unit by mid-February 1915. He won the DCM at the Second Battle of Ypres in April, became CSM in August and was commissioned in the field the following month. In June 1916, he won the MC at Mount Sorrel. He then had a short spell as Chief Instructor at the Canadian Engineers Training Depot in England, during which time he was given a regular commission in the Royal Canadian Engineers. He was back in France by January 1918 and won a bar to his MC at Drocourt-Quéant. He was also mentioned in dispatches and ended the war as a temporary Major.

In between the two wars he had a very busy time, including a course at the SME, Chatham, 1920–2, military engineering instructor at the Royal Military College, Kingston, Canada, 1923–4, and Staff College, Quetta, 1925–6. He had considerable experience of works services, holding the appointment of ADES for a number of years and being senior staff officer for the unemployment relief projects from 1932 to 1936. He was made a brevet Lieut-Colonel in 1934. In 1936 he was put on planning for industrial mobilization, and in 1938 he attended the Imperial Defence College in London.

When the Second World War broke out in 1939 he became GSOI, 1st Canadian Division, and came overseas with them, being promoted Colonel in June 1940. On the formation of VII Corps in July he was appointed BGS (Cdn), where his duties were largely concerned with planning the future organization and included a year in Canada to co-ordinate it. In December 1941, he became DA and QMG, Canadian Corps, taking on the same duties in the higher headquarters, as a Major-General, when First Canadian Army was formed in April 1942. In 1943 he was made CB. In the same year he was the Canadian representative at COSSAC. He returned to Canada in 1944, becoming Inspector-General, Western Canada in 1945; he retired in 1946. He was awarded the Canadian Forces Decoration with two clasps.

Brigadier General G H Boileau CB CMG DSO

In post-war years his civilian posts included work for the Department of Veterans' Affairs and the Anglican Church of Canada Indian Schools Administration and he played a very active part in many local organizations in Ottawa. He was President of the Military Engineers Association of Canada in 1950–1 and Honorary Lieut-Colonel of the Carleton and York Regiment from 1946 to 1951.

I first met him when I was a Cadet at the RMC Kingston in 1923 and have known him ever since, up to his last task as Chairman of the RCE History Committee. He was a man of unlimited energy and initiative and worked untiringly at all his tasks. This was particularly noticeable in his staff employment, when we used to wonder at times if he ever slept. He was a man of strong moral and religious convictions with an unswerving sense of duty; he never neglected a worthy cause nor spurned a distasteful task. He was a man who grew in stature and likeability the better one knew him; he was somewhat shy at heart and never sought personal fame; his passing is a great loss to his friends and will be felt by many who never knew him. He leaves a widow and one son, Lieut-Colonel Malcolm Turner, RCE. A.J.K.

BRIGADIER-GENERAL G. H. BOILEAU, CB, CMG, DSO

Guy Hamilton Boileau was born on 27 September 1870, the son of Major C. H. Boileau of the 61st Regiment. He was educated at Christ's Hospital and the RMA Woolwich.

In February 1890 he was commissioned into the Corps. As soon as he had completed the necessary Young Officer Courses at the SME Chatham, he started on the varied series of military operations in which he took part during the next thirty years. In October 1891 he was sent to Sierra Leone and by the time he was 22, he had been Mentioned in Despatches in two West Africa Expeditions (of which he had some fascinating stories to tell!). The first of these was the one which took place in March/April 1892 and ended with the capture of the town of Tambi. The force, which included Boileau's RE detachment armed with fifty Hales war rockets, gun cotton and other equipment, went by sea from Freetown and landed at Robat. Boileau then led it by compass through thick forest to reach Tambi, which was defended by a stockade. The town was captured on 7 April, but Boileau himself was knocked down in the process of blowing an entrance. However, he soon recovered and took part in the second expedition where he again had charge of rockets and commanded the Sapper contingent. This time the force proceeded by Bathurst, up the Gambia River to the enemy's capital at Fodi. The RE rockets set fire to the town and enabled the West Indian Regiment to enter and take it.

Boileau then returned home with his two Mentions, the West Africa Medal and the thanks of the Commander-in-Chief. He was at home only for a few months, first on special duty at Strensall Camp in Yorkshire and then in C Depot Company at Chatham.

Early in 1893 he went to India, being posted first to the Indian Submarine Mining Company at Bombay and a little later to the Bombay Defences Division of Military Works. Before the end of 1893, however, he had joined the troops he loved best, those of the Bombay Sappers and Miners at Kirkee, where he was first a Company Officer in 1 Company before becoming Corps Quartermaster a year later.

His next operation was that with the Chitral Relief Force in 1895 which faced opposition and required extensive work on roads and bridges for its advance. Boileau with his Sappers and Miners was responsible for constructing the southern face of the road Dargai to Khar and he helped to bridge the channels of the fast-flowing Swat River at Chakdarra with pontoons on several occasions. Additional pontoons had to be sent for from Roorkee and Boileau had to bring these up over the Malakand Pass and along the narrow road to Chakdarra, the only transport being carrying by working parties or haulage by elephants. The latter, willing, hefty and valuable beasts although they were, presented their own hazards to their Sapper commander. Boileau used to tell the story of how, one pontoon bridge having been got across the swift current with difficulty, it was decided to swim the elephants across to haul more pontoons on to yet another channel ahead. They were taken some distance upstream so as to avoid any risk of their being swept by the current on to the precious pontoon bridge. As soon as they entered the stream, however, they commenced to play about, dowsing each other with water and generally enjoying themselves. The sappers looking on suffered agonies during these gambols as the playful beasts were being swept by the swift current down towards the bridge. However, the mahouts beat and yelled at their charges and the elephants at last made the further shore only a few yards above the bridge.

After these operations Boileau returned to Kirkee where he acted as Commander of A Depot Company until the end of 1896. He then went to Aden for a year to command 2 Company, Bombay Sappers and Miners, which he brought back to Kirkee.

In July 1900 Boileau, still a Lieutenant, sailed with his Company to join the China Expeditionary Force. They did not arrive in Tientsin until 11 August, too late to take part in the Relief of Pekin. However, soon after its arrival the Company fought a successful little action against a large gathering of Boxers and took several prisoners. For his services Boileau was Mentioned in Despatches.

He returned to Kirkee in October 1901 and took his Company to Quetta early in 1902. He did not stay there long however, for he was selected to take charge of the detachment of Sappers and Miners which went to England as part of the Indian Coronation Contingent. On his return to Kirkee he again commanded 1 Company for a time as well as doing duty as ADC to the Governor of Bombay.

The next twelve years gave him plenty of peacetime soldiering with all the varied engineering tasks Sappers and Miners were called upon to do in the Deccan and in Baluchistan. He put his experience to good use in the years just before the First World War when he became the Inspecting Officer of all the Sappers of Imperial Service Troops in India with headquarters at Roorkee. He was promoted Major in 1910 and after a period in the Adjutant General's Branch at Army Headquarters was Garrison Engineer, Karachi, at the outbreak of war in 1914. He then immediately went to France.

In March 1915, Boileau, then a Field Engineer of the Indian Corps, was in command of a small force consisting of one Section of Bengal Sappers and Miners and one Company of Pioneers. They were advancing to take over some trenches supposed to have been evacuated by the enemy when they came under heavy fire and had serious casualties. Nevertheless, they sealed off their trenches from the Germans and thus played their part, after repulsing a strong counter-attack, in the retaking of Neuve Chapell. In September 1915 Boileau was appointed CRE 7 Division. He took part, under XV Corps, in the Somme battles of 1916 and in other operations under X Corps in 1917. In November 1917 he became Chief Engineer X Corps with the temporary rank of Brigadier-General. When the War ended he was Chief Engineer II Corps. For all these services, he was awarded a DSO and promoted to Brevet Lieut-Colonel in 1915, was made CMG in 1918, and also received the Montenegrian Order of Danilo, third class.

He then went back to India, where he was immediately concerned in the Third Afghan War of 1919. In that he was Deputy Chief Engineer in the Works Directorate on the North-West Frontier. For his services there he became CB.

Towards the end of 1919 he went back to Karachi as ACRE. Then in early 1921 he was given command of the Karachi Brigade with the rank of Colonel Commandant. He did not stay long in this appointment because he went on, in March 1922, to what his friends thought was his happiest post, Commandant of the Bombay Sappers and Miners, newly honoured with the title of Royal.

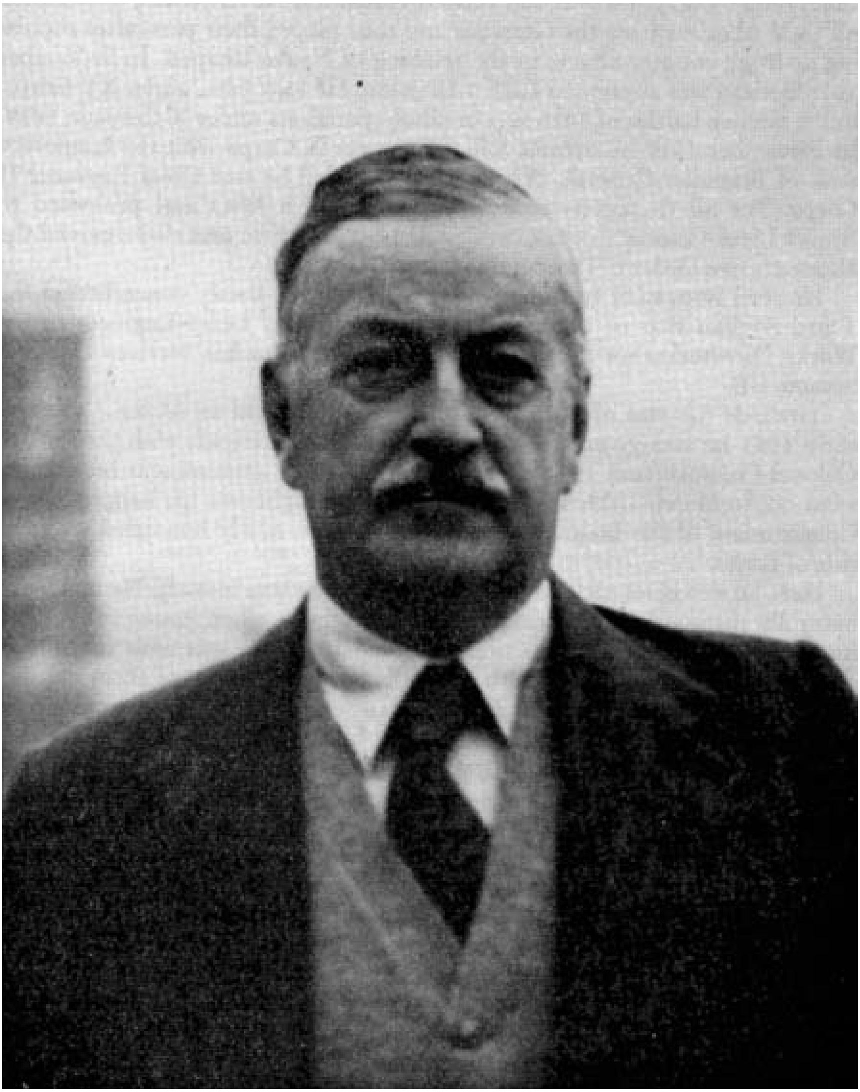
Here he was immensely popular just because he was himself. He had had a naturally distinguished bearing and presence even when young; these had increased with the years. His breast of medal ribbons was most impressive and gave him much "izzat" with his Indian sappers, many of them grizzled veterans themselves. Although he may have seemed at times rather aloof, he was always helpful and friendly. Certainly his British officers as well as his Indian officers and men thought him a wonderful Commandant.

He was fond of all kinds of sport and encouraged his Corps of Sappers and Miners to great heights of achievement, but his chief interest was in shooting, yachting and rowing. His shooting parties were memorable occasions, and his contribution to Kirkee rowing was very considerable. He was a grand stroke in the orthodox style and inspired his crews (of which some members, including the writer, had never rowed before) to win races behind him.

His Indian career continued when he was promoted in 1925 to be a Chief Engineer again, this time of the Western Command. Here he found to his joy that, in addition to all the Operational and Military Works responsibilities, he had under him no less than three companies of his beloved Royal Bombay Sappers and Miners. He thought out difficult and searching tasks for them all over Baluchistan and the Zhob. The writer, who commanded one of the companies, well remembers the seemingly impossible work set him; yet such was the Chief Engineer's encouragement and help that all turned out well and there were a lot of proud sappers after they had earned his praise.

He retired in 1927 with the honorary rank of Brigadier-General. However, he continued his happy relations with the Corps of Royal Bombay Sappers and Miners and was their Colonel from 1936 to 1944.

After he retired, he led a happy life in Cornwall with his wife and his two growing daughters. He played golf, sailed boats and interested himself in local



Brigadier A S Redman CB

affairs. However, his service to the Army was not over yet. In 1940, with the formation of the Home Guard he became Zone Commander for Cornwall. Should the German troops have come, it is certain that this veteran of so many varied compaigns would have applied his great experience in inspiring his Cornish Home Guard soldiers to help, probably in most unorthodox ways, in frustrating some hostile designs.

Right up to the time of his death, two months after his 92nd birthday, he retained his keen interest in everything that was going on. A little hard of hearing, perhaps, and not as active physically as he used to be; but his eyesight was as good as ever, his memory and his sense of humour still strong, as the writer realized to his joy when visiting him as recently as last September.

He left behind him, when he died on 5 December 1962, his wife, Violet, daughter of Colonel W. J. S. Fergusson, King's Dragoon Guards, and his two daughters, both happily married. F.E.W.S.

BRIGADIER A. S. REDMAN, CB

Arthur Stanley Redman, son of T. E. Redman of Shawford, Hampshire, was born on 25 September 1879. He was educated at Repton and the Royal Indian Engineering College, Coopers Hill which from 1871 to 1906 trained engineer, telegraph and forest officers for the public services in India and Burma.

He was commissioned into the Royal Engineers on 28 August 1901. At the conclusion of his training at Chatham in 1903 he attended a Railway Traffic Course run by the Great Western Railway and later served for a short while with the 53rd (Railway) Company, then at Longmoor, to be joined soon after by 8th and 10th (Railway) Companies from Woolmer, thus establishing Longmoor as the home of Sapper Railway Units.

From 1904 to 1909 he was employed with the Colonial Survey in Jamaica and South Africa. From 1909 to 1913 he was an Instructor in the Construction School of the SME Chatham. In 1913, being then a Captain, he returned to Longmoor to command 8th (Railway) Company. After a period of just under a year with the Company he was posted as a General Staff Officer third grade in the Military Operations Division, the War Office.

On the outbreak of war in August 1914 he was moved to the Movements Branch of the War Office where he remained until 1920. He started the war as a Staff Captain and rose to become Deputy Director of Railway Transport. During that period he was the War Office representative on the Railways War Manufacturers' Sub-Committee, a member of a Committee that controlled a number of major inland waterway and canal systems and a Committee that dealt with all home railway movement, including the co-ordination of government requirements for rail transport where they were likely to clash with civilian needs. He was mentioned in despatches in 1919 and made CB. During his time with movements in the War Office he won both a Brevet Majority and a Brevet Colonelcy.

In 1920 he was seconded to the Ministry of Transport to become Traffic Superintendent of the Somerset and Dorset Railways with Headquarters at Bath.

In October 1921 he was appointed Assistant Director of Movements at the War Office and in July 1924 he became Assistant Director of Transportation. From October 1926 to January 1931 he was AAG (AG5) at the War Office, his last military appointment before retirement.

From 1931 to 1937 he was Chairman of the West Midland Traffic Commissioners and from 1934 to 1937 he was also Chairman of the Licensing Authority, West Midland Traffic Area.

On the outbreak of the 1939–45 war he was re-employed in the Army, although 60 years of age, as a Deputy Director in the Ministry of Supply until his final retirement, with the honorary rank of Brigadier, on 31 August 1941.

On 19 June 1909 he married Vera Mary, youngest daughter of James Kay of Lark Hill, Timperley, Cheshire, at the Parish Church of Calne. They had one son, now Major-General D. A. K. Redman, CB, OBE, Colonel Commandant REME and the present Director of Electrical and Mechanical Engineering the War Office, and one daughter. His wife died last year. He died at Sidmouth on 9 March 1963 aged 83 years.

COLONEL H. E. G. COWIE, CBE, DSO

HENRY EDWARD COLVIN COWIE was born on 17 December 1872, the son of Henry George Cowie, Esq of Tiverton, Devon. He was educated at Shrewsbury School and the RMA, Woolwich, and played in the football first eleven both at School and at the Shop.

He was commissioned in the Royal Engineers in February 1893 and whilst at Chatham as a young officer he played football for the Corps and he was the centre forward of the Training Battalion RE football team which did so well in the Army Cup and the English Amateur Cup during the 1893–4 season.

After completing his training at the SME Chatham he went to India in 1895 and never again served in the United Kingdom. He was for some months attached to the Military Works Department at Bombay, but shortly afterwards he began his long and famous connexion with Indian Railways when he moved to Lucknow where he was employed on the Oudh and Rohilkund Railway, and later on the Mari-Attock Railway. In 1899 he was moved to Nowshera, as an Assistant Engineer. In September 1900 he was sent as an Assistant Field Engineer to join the China Expeditionary Force, and next year was appointed to its Railway Staff. In July he arrived at Tientsin with a railway detachment, but was left there in charge of railway repairs while the advance on Pekin took place. He did, however, send a small detachment to Peiping to assist in railway construction work. He stayed in China until January 1903, employed for the last few months under the Chinese Government. For his services he was mentioned in despatches and awarded the DSO.

He returned to India as an Executive Engineer third grade on the North Western Railway, and in 1906 became Assistant Engineer first grade at Kushalgarh. In 1909 he left the North Western Railway for a brief attachment to the Bombay Sappers and Miners at Kirkee before going to Calcutta as an Executive Engineer third grade in the Public Works Department. During 1910–11 he was employed mainly on the construction of bridges over the Ganges. In 1913, after a long leave spent in the United Kingdom, he returned to the North Western Railway at Lahore.

In 1915 he went to France as a member of the Railway Staff, and from 1917 until 1920 he served under the Director General of Transportation. In 1920 he held the appointment of Controller of Transportation France and Belgium for a short while. For his services he was awarded the CBE.

In 1921 he returned to Lahore as Engineer-in-Chief, North Western Railway. From 1923–5 his appointment was that of Chief Engineer North Western Railway until, in 1926, he became Senior Government Inspector of Railways, Madras Circle.

He retired in December 1927.

In 1903 he married Mary Theodore, eldest daughter of the Rev D. G. Thomas, rector of Hamerton, Hunts. They had one son and two daughters.

He died at Stockport on 16 March 1963, at the great age of 90. He was cremated on 20 March 1963. There were, at his request, no flowers but instead he had asked that donations should be sent to the Freedom from Hunger Campaign.

COLONEL H. A. W. MICKLEM, CB, CMG, DSO

Henry Andrew William Micklem was born on 29 June 1872 the eldest son of Major-General Edward Micklem, late RE. He was educated at Winchester College and the Shop. He was commissioned into the Corps on 1 August 1891.

He served in the Sudan Expedition of 1897 and was wounded, mentioned in despatches and received the DSO. In the South African War he served with the railway troops under Lieut-Colonel Sir Percy Girouard, RE, Director of Railways. He was wounded. After this war he became Chief Engineer of the Central South African Railways, among his duties being the organization of the repairs to the many railway bridges damaged during hostilities. The 10th Railway Company RE was placed at his disposal for this purpose and the unit gained valuable experience.

In the First World War Micklem, who had retired, joined the Directorate of Railways, Light Railways and Roads at the War Office and was responsible for purchasing railway, light railway and road materials and stores for all theatres of war. His valuable services were recognized by his being made a brevet Lieut-Colonel and receiving the CMG and CB.

Colonel Micklem followed his father into the City becoming Director, and in several cases Chairman, of Investment Trust and other companies. As

Colonel H A W Micklem CB CMG DSO

Chairman he played a very leading part which contributed to the success of his companies. His main interest was in his work, and in this he did not spare himself. In his latest years, though handicapped by failing sight, he fully maintained the clarity of his judgement.

Colonel Micklem never married; he lived at his country home near Henley when he could get away from his work in London. He died on 9 March 1963. A Service of Remembrance was held for him in St Michael's Church, Cornhill on 5 April 1963.

As one who served with him in South Africa, at the War Office and in the City I had every opportunity of appreciating his great ability, equable temperament and unassuming spirit of service. H.O.M.

Book Reviews

THE BOXER UPRISING

By Victor Purcell

(Published by Cambridge University Press. Price 45*s*)

Victor Purcell's work differs from the many other books on the subject in that its prime object is not to describe *what* took place, but *why* it took place. This has taken the author's researches back into the origins of the Boxer movement and forward again through its historical development to the climax of 1900.

The first official mention of "Spirit Boxers" or "Fists" was in an Imperial decree of 1727 which proscribed them as an illegal secret society. Such societies have always been a feature of Chinese life, and during the Manchu dynasty many of them were dedicated to overthrowing the régime and restoring the native Mings. The author takes us through a fascinating but frustrating maze of underground organizations, such as the White Lotus, Small Sword, Triad and Elder Brother societies, with which the Boxers were supposed to have been associated at different periods.

Purcell next considers the conditions favouring the development of the "Fists". After the death of the great Ch'ien Lung the Manchu dynasty began its slow decline, hastened by the murderous Taiping outbreak in the middle of the century and by disastrous wars with Great Britain, France and Japan. The increasing pressure of the outside world and the economic depression due to floods, famine and the excessive importation of foreign manufactures all contributed to discontent and the feeling that the régime had "forfeited the mandate of Heaven".

There was a Reform Party sponsored by the young Emperor Kuang-Hsü, which advocated adopting Western techniques to enable China to hold her own in the modern world, but a *coup d'état* engineered by the vicious old Empress Dowager put the reactionaries firmly in the saddle, and an anti-foreign atmosphere was fostered by the Court.

In 1898 the Boxers emerged into the limelight as the "Patriotic and Harmonious Fists", breathing fire and slaughter against foreigners, their Christian protégés and the Dynasty. Their activities were confined to the northern provinces, but the Court, by encouraging the xenophobes and suppressing the anti-Manchu elements, contrived to direct their wrath against foreign influences and to win their support for the reactionary government.

The author expresses the opinion that neither the Chinese authorities nor the Boxers would have ventured to attack the persons of foreigners had not the Powers played into the hands of the extremists by sending troops up from Tientsin to protect the legations. Against this it is arguable that outrages had already been committed against missionary property and native Christians, and that a British missionary had just been murdered. The short campaign which followed laid China prostrate at the feet of the Powers, which took the opportunity of securing all the political and economic advantages which their mutual rivalries would allow.

Victor Purcell, in summing up, is inclined to lay most of the blame for what happened upon the West, firstly for bringing about conditions which made the outbreak inevitable, and secondly for taking undue advantage of an incident which involved small loss of life and affected only two or three provinces. He does not lay sufficient stress on the fact that the Manchu régime and Chinese society already stood condemned by the inexorable march of history, nor does he allow for the feelings of horror and indignation which the Boxer atrocities and the Chinese government's connivance aroused in the outside world at the time. Moreover, he fails to give credit to the West, and particularly Great Britain, for the benefits offered to the Chinese people in the spheres of education, medicine and honest administration; notably in the organization and operation of the Maritime Customs. He brings out, however, the point that the "Fists", albeit poorly organized and crude in their methods, were a symptom of the distemper which was to culminate in the revolution of 1911 and pave the way for the Nationalist and Communist movements.

The book is very fully documented from widely different sources, both British and foreign, and includes references to Chinese Communist material hitherto unavailable.

J.V.D.-H.

COUNTER GUERRILLA OPERATIONS

By N. D. Valeriano and C. T. R. Bohannan (Pall Mall)

(Published by the Pall Mall Press Ltd. Price 40*s*)

This is a most readable and well-balanced study of many aspects of counter guerrilla operations. It is written against a background of carefully analysed facts about the Communist-stimulated guerrilla war in the Phillipines after the end of the Second World War. Both authors took part in this war. Colonel Valeriano was in the Phillipine Army: Colonel Bohannan a regular soldier in the United States Army.

Since the end of the Second World War the British Army has taken part in a number of "sub-conventional" wars of this type. Malaya, Cyprus and Kenya are examples. As nuclear stalemate becomes more likely, so are we more likely to become embroiled in similar operations in the future. This book should, therefore, be both interesting and valuable to every professional soldier.

The authors have drawn intelligently upon recorded experiences from a wide variety of previous guerrilla wars. Their studies range from Clauzwitz *On War* to C. S. Forester's *Rifleman Dodd*. They have studied and quoted from our counter-guerrilla operations in Malaya. Their conclusions regarding the essentials to success are systematically reached and few will disagree with most of them.

It would be possible to write the greater part of a military text book on the techniques of counter-guerrilla operations from this excellent book.

E.C.W.M.

THE RED ARMY OF CHINA

By Edgar O'Ballance

(Published by Faber and Faber, 24 Russell Square, London. Price 30*s*)

At the head of the Author's Preface we read Napoleon's dictum; "Let China sleep, when she wakes the world will be sorry." Today it is to be supposed that China no longer sleeps: a small section of her army was encountered by our own troops in Korea: a recent eruption on India's frontier made headlines in the newspapers—it was a journalists' saying once that a revolution in China is not news: a dog fight in the next street is—and now we hear reports of China preparing to make thermonuclear tests. Napoleon may yet be proved right: and it behoves those who follow the profession of arms to know about the Red Army of China. Major O'Ballance's book provides a suitable foundation for beginners to start building that knowledge.

The book starts with the revolution in China of 1911 and traces the course of events in China from then onwards. We see the rise of the Nationalists with their German advisers; we hear of the difficult struggles of the early Red revolutionary forces of Mao-Tse-tung; of the opposition to the Japanese in Manchuria; of the Russian intervention and withdrawal in 1945; the Civil War and the departure of Chiang-Kai-Chek to Formosa; and finally we see Mao firmly established as the Head of the State. It is a complicated story and cannot have been easy to piece together. As the Author says; "What I have written is most probably what did happen"; and to a newcomer (such as your reviewer) it all seems to ring true.

Everyone knows of the vast manpower of China and it is interesting to read of the colossal scale on which the various parties struggled for power. Warlords and Generals with picturesque names like Liu the Turncoat, or Peng the ex-Nationalist Brigadier flit across the pages with 8,000 peasants in one place, or 30,000 mounted men in another; and we are told "two million guerillas and active sympathizers" are liquidated in the process. It is no wonder that commanders, brought up in that school, are prepared to squander life with a prodigality that is abhorrent to the West.

Besides tracing all this historical record, the Author gives a chapter on his assessment of the Red Army of China dated to May 1961. This alone represents no mean work of military intelligence in its technical sense. Your reviewer has no means of ascertaining its accuracy: but he feels that the Author may be a trifle optimistic in his statement that the Chinese soldier, "in adversity, would probably seek the traditional 'avenue of escape' "—that is, he would change sides. Till this is proved by events it would be wise not to count upon it.

Meanwhile Major O'Ballance's book is commended to readers as a work that is easy to read, on a subject that few soldiers in the West know much about, and which is likely to become more rather than less important in the years to come. We shall, perhaps be sorry; but we should not be intellectually unprepared for what China may have in store.

M.C.A.H.

THE PROFESSION OF ARMS

The 1962 Lees Knowles lectures given at Trinity College, Cambridge

By Lieut-General Sir John Winthop Hackett, kcb, cbe, dso, mc

(Published in full by The Times Publishing Company Limited, Printing House Square, London EC4. Price 2*s*)

Some private research has revealed that the man who endowed this lectureship, Sir Lees Knowles, was born in 1857, educated at Rugby (where he subsequently endowed a scholarship), was President of the Cambridge University Athletic Club when at Trinity; was President of the Local Government Board 1887–92 and the Board of Trade 1895–1900; was Chairman of the East Lancashire Territorial Association, a holder of the Territorial Decoration, and a writer on military subjects, including the Peninsular War and the Minden campaign. He was created Baronet in 1903 and died in 1928. Former holders of the lectureship include Ironside, Wavell, Liddell-Hart, Tedder, Weeks, Fitzroy MacLean, Ismay, Horrocks, Harding, Roskill and Tizard.

Your reviewer feels compelled to mention these facts because he believes that many intelligent readers will not be aware of them and the printed version of General Hackett's lectures should be related to the background outlined above. To those who attended the lectures—probably far fewer than the occasion required—all this was no doubt well known, and it would have been easy for the publishers to have included a note for the benefit of the wider public to whom the printed version is now available.

Read in this context various aspects of the lectures fall better into place: the felicitous dedication "To an unknown undergraduate"; the many Latin words and Greek remarks—even some of the English words, such as abanausic—are appropriate to a learned audience only, and might seem rather out of place to a military one; and references to University life are much more apt in Cambridge than (say) Camberley.

Your reviewer also feels that the printed version should include a brief biography of the Lecturer. That he is a distinguished soldier may be deduced from his rank and decorations, but his academic record at Oxford—which is adequate by any standards—should also be recorded.

It is best to get these short-comings out of the way quickly because the lectures themselves are of a very high order; being erudite yet comprehensible, learned yet readable and a quite outstanding piece of work in every way.

There are three lectures, each divided into two or three sections. The first lecture deals with "The Origins of the Profession", "Knights and Mercenaries" and "The Armies of the Nation States". The Lecturer outlines the development of the profession of arms, which he likens to that of "medicine and the law, as well as to holy orders", from the dawn of recorded history till the mid-eighteenth century. We have a discourse on the military systems of Sparta and Rome, showing how the man-at-arms fitted into the parent state. This is a recurrent theme and illustrates how: "When a country looks at its fighting forces it is looking in a mirror". Sparta's likeness was purely military and nothing now remains save legends of military prowess, whereas Athens is immortal. From these early times we are led through the centuries to a period when soldiers began to live in barracks—the Spartiate might sleep at home though he had first to dine in the common mess—and wear uniforms.

Your reviewer would have liked to have had the General's views on the soldiery of Oliver Cromwell, and on the contemporary attitude of society towards them. It may be that the soldier's image in Britain today is distorted by visions from those times. He would also have liked to hear something of a young Athenian ADC who revived the morale of his Spartan superiors after the defeat at Cunaxa and led the Ten Thousand to the Sea. One feels that Xenophon was a man after the General's heart—a man-at-arms, a scholar, a sportsman—and also, of course, a cavalryman. But perhaps time or space forbad these digressions; and the same inhibitions should apply to your reviewer.

The second lecture deals with "Prussia and Napoleon" in the first part, and "The Nineteenth-century Officer" in the second. This lecture covers a period when the profession was, so to speak, professionalized. War, in the words of Defoe, was becoming an affair of "less blood and more money". It was not till 1914 that both were squandered with reckless prodigality, but that comes in the third lecture. We are reminded how Frederick the Great inherited a military system held together by the fiercest discipline; but even so, many of his actions had to be dictated by tactics to avoid desertions: his commanders, for instance, were warned not to bivouac near woods. And the ideological appeal of the American Revolutionary wars was insufficient to prevent many deserters changing sides.

It is during this lecture that General Hackett introduces the question of the social status of the army officer in society. Entry to the Prussian Officer corps was restricted to aristocrats only, until at least 1808: and in Britain a captaincy in 1856 cost £2,400. We are reminded how Wellington had no great regard for soldiers; but he loved his country and its aristocratic way of life—which included giving commissions to the top social classes only—and he used his military genius to defend it. When victory was achieved "he threw the instrument aside without compunction" (to quote Sir John Fortescue). And as late as 1850 the Duke of Cambridge remarked; "The British Officer should be a gentleman first and an officer second." This raises speculations, pertinent today, and mentioned again by the lecturer.

As the nineteenth century drew to its close, every national army tended to be better trained and equipped than formerly: all nations had their military and staff schools, and professional soldiers stood apart from the body of the State, but still a part of it. In different countries the control of the armed forces varied with the temperament of the State.

In a professional army "the unwritten clause of unlimited liability in the contract" creeps into the foreground. The professional man-at-arms cannot opt out of his engagement when things get too hot, and this sets him apart from other professionals. It is a basic fact of military life.

The third, and last, lecture deals with "Society and the Soldier, 1914–1918" and "Today and Tomorrow". To many readers this will be the most interesting, for it comes within a time-bracket that many know from personal experience. The Lecturer traces, through close reasoning, the purposes of armed forces, their characteristics and the men who embrace the profession of arms, and the relation of the forces themselves and their individual members with the parent society. Aristotle, Toynbee and Kant are hauled in to show that armed forces are necessary: that life in them can be (and often is) ennobling: and that it is not the man-at-arms who starts a war. It is started, and largely run, by the politicians, but the social consequences of any military ineptitude by generals, when once it is started, are unbounded. We are reminded of the bitter harvest reaped by France from the fatal doctrine of *l'attaque à outrance* which was espoused by her General Staff in 1914, and the no less sombre consequence of our own campaigns at Loos, the Somme and Passchendaele "when inadequacy in command caused grievous loss of life for no return". Others had responsibilities too, but the Generals have a heavy load to bear.

The Lecturer attributes the British inadequancy in the conduct of the fighting to the amateur cult of the British officer corps. "They were not well trained and were expected to be neither industrious nor particularly intelligent." This attitude of the officer corps, the Lecturer feels, reflected a contemporary British attitude. The British Armies of 1914–18 were a reflection of Britain herself; valiant but not particularly efficient.

From World War I we then move to "Today and Tomorrow". The Lecturer steers a course between the numerous extremes: total war, total disarmament; peace, indeed, and war itself. He points to events at the time he was speaking (November 1962); India was fighting China, United Nations troops were fighting in the Congo: there was civil war in the Yemen and American bayonets were ensuring the entry of an unwelcome student into a University in Mississippi. None of this could have been predicted in 1961 when there was other fighting in progress in other places. "It is difficult to say how conflict will emerge," he says. "All we can say with confidence is that it will occur." And because of this the need for armed forces not only exists today, but it is likely to exist for many years to come.

In view of this, what sort of men should we have in our services? Where does the "gentleman" stand in the officer establishment today? The terms of reference for officership are altering: they must be better trained and of greater mental calibre, yet they must not be of the "nine-to-five type", because of the unlimited liability clause in the contract. The Army is faced with a complex problem and the Lecturer gives some indication of the trouble it is taking to recruit the right officers and to give them the right sort of education, training and way of life. He makes the Army sound—as indeed it is—an attractive calling. "It gives much and takes more, enriching freely anyone prepared to give more than he gets." With these fine sentiments most soldiers will agree.

Your reviewer makes no apology for a lengthy notice of these admirable lectures. Much has been omitted from the notice that should have been included. Let the reader send his two bob to the publishers and read the document for himself. He will not be wasting his time or his money. And if he follows up even half of the references he will be helping himself to a liberal and military, education.

M.C.A.H.

FATIGUE OF METALS

By P. G. Forrest, BSc(Eng), AMIMechE

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 70*s*)

The author, a Principal Scientific Officer of the Metallurgy Division National Physical Laboratory, Teddington, Middlesex, claims that his treatise is the first comprehensive British book on fatigue to be published over the past thirty years, although many papers on the subject have been included in the journals and magazines of the leading engineering Institutions. When one realizes that most of the material failures in engineering components and structures are due to fatigue it will be appreciated that this book will be a welcomed addition to the libraries of Universities, Colleges of Technology and design offices.

The book is written to serve as an introduction to the subject and as a reference book for engineers and metallurgists. It will also be useful to graduate students, designers and those working in research on strength of materials.

After a brief introduction to the characteristics of fatigue fractures and the practical methods of detecting fatigue cracks, the author deals with the theory, methods, and machines used for fatigue testing. This is done in considerable detail with descriptions and illustrations of the modern machines used by the National Physical Laboratory and British and foreign manufacturers. It is supplemented with some very useful tables giving comparative specifications of testing machinery now in general use.

A chapter is devoted to the consideration of alternating fatigue strengths determined either in bending or direct stress on plain unnotched specimens at air temperature. The selection of metals discussed range over iron and steel, steel wire, cast iron and steel, and most of the well-known non-ferrous alloys.

Chapters are also allocated to: the influence of stress conditions on fatigue strength, stress concentrations, surface treatment of metals, corrosion fatigue and fretting corrosion, the influence of temperature, and the strength of joints, components and structures.

The latter part of the book covers a brief historical survey of the mechanism of fatigue, the latest engineer design practices to prevent fatigue, the fatigue of non-metallic materials, and a miscellany of fatigue data in table form.

A feature of the book is the large number of specifications, comparative tables, graphs, and reading references included. These make this treatise a very good, compact reference book for designers and engineers.

The book is excellently printed on quality paper.

F.T.S.

LIQUID PROPELLANT ENGINES

By N. I. Melek-Pashayer

Translation edited by Dr B. P. Mullins

(Principal Scientific Officer, Ministry of Aviation, Farnborough)

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 20*s*)

The operation of modern types of rockets and air-borne missiles is one of the most efficient practical applications of Newton's Third Law of Motion, and their development is the result of centuries of engineering effort.

The Chinese first used rockets in their defence of Kai-fung-fu (Peking) in 1232, when the city was besieged by Mongul hordes. Since that time the use of rockets has progressed through various stages of development. Early in the nineteenth century Colonel Sir William Congreve achieved a flight range of 2,000 yds with an incendiary rocket weighing 30 lb, and these were used with considerable effect by the British in the naval attack on Boulogne in 1806, and in the preliminaries preceding the Battle of Leipzig in October 1813 by the famous Rocket Troop. Later, in 1892, Royal Engineer (Hale) Rockets were used in the Gambia operations.

The present performances of the USA and USSR rockets are a far cry from those of the "arrows of flying fire", used by the early Chinese. Possibly an emergent China will one day achieve parity with these advanced experts of rocketry.

This book has been written as an elementary introduction for students and technologists who wish to learn the basic principles of the design and operation of liquid propellant engines. The subject matter is simply explained and readers with a school knowledge of mathematics and the rudiments of chemistry will find the design text easy to understand.

The Chapters dealing with the basic layout and operation of these engines are well written and supplemented by good schematic diagrams and descriptions of the German V2 missile.

A number of interesting tables are included to show the comparative characteristics of modern British, German and American rockets and these cover their flight performances, engines, fuels and subsidiary apparatus.

The Chapter dealing with the composition and selection of fuels to obtain the high specific thrusts required is an excellent precis of this complicated branch of rocketry science.

Lists of reference books and suggestions for further reading are included.

This book is highly recommended to students and engineers who are seeking an introduction to the larger treatises on the subject matter.

F.T.S.

TABLES OF LAMÉ POLYNOMIALS

By F. M. Arscott and I. M. Khabaza

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price £7)

This is Volume 17 of the Pergamon Mathematical Tables Series. The authors are members of the Battersea College of Technology. The tables were calculated on the Ferranti "Mercury" machine at the London University Computer Unit during 1960–61. Lamé polynomials are solutions of Lamé's differential equation, which is used in a number of different forms. The contents cover:—

A summary of the theory of the polynomials with references to elementary properties, tabulated forms, methods of tabulation, the relation between Eigenvalues, and approximations in limiting cases.

A section, devoted to the method of computation, includes a statement of the problem, calculations of the coefficients and Eigenvectors, and a schematic version of the programme.

Another section gives details of the Ferranti Programme.

All entries in the tables are on "floating-point" notation, and consist of six digits followed by the "characteristic" which is a signed two digit number. Use of the tables, which cover eight different types of Lamé Polynomials, is explained.

The tables, boldly printed on good paper are easy to read, and they are well-bound.

F.T.S.

VOCABULARY OF FOUNDRY PRACTICE

In six languages, (English, Czech, German, French, Polish, Russian)

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price £6 nett)

This vocabulary is based upon the draft prepared by the late Prof K. Gierdziejewski of Warsaw and the Terminology Committee of the Polish Foundrymen's Association. The English terms and definitions have been checked by W. C. Newall, PHD, DIC, ARCS, FRIC, on behalf of Pergamon Press Ltd.

The arrangement and layout of the vocabulary is in accordance with the recommendations of the ISO/TC 37 (International Organization for Standardization, Technical Committee for Terminology—Principles and Co-ordination), and the numbering system of the entries is clearly one which can be adapted for computer reference use.

The vocabulary is divided into ten main groups, most of which are sub-sectioned to facilitate reference. The group subjects are:—Fundamental concepts: Pattern, making: Moulding materials: Moulding practice: Melting of metals: Pouring moulds: Pressure die casting: Finishing of castings: Foundry handling equipment: and Castings defects. The heading of each group and section is given in six languages.

A total of 1,269 entries in English are given and adjacent to each are the English, Czech, German, French, Polish and Russian definitions. The English definitions despite their brevity are clear in reason, arrangement and accuracy. The other five language definitions are mainly the foreign equivalents of the original English entries.

Some 120 well drawn illustrations are utilized to amplify those definitions which are difficult to explain with a few words. They are mostly small drawings of moulding accessories and furnace equipments.

The vocabulary is fully and separately indexed in the six languages.

This book would be of considerable use to students seeking qualification as interpreters, and to foundry engineers engaged in foreign business contracts. Military engineers would find it useful occasionally, although a need exists, particularly in time of war, for a whole series of multilingual vocabularies covering the complete range of civil, electrical and mechanical engineering fields.

F.T.S.

Technical Notes

CIVIL ENGINEERING

Notes from *Civil Engineering and Public Works Review* for February 1963

PILE DRIVING BY VIBRATION: A very interesting description of the progress made in the process of driving piles by vibration as opposed to hammer blows. The natural frequency of soil is from 6 to 60 cycles per second and, for an average pile, the natural frequency is about 200 cycles per second. The theory is that, if the pile is vibrated at its natural frequency, the apparent weight of the pile is magnified and the pile forced into the ground. Alternatively, if the pile is vibrated at a frequency approximately equal to the natural frequency of the soil, the resistance of the soil is reduced. Continental practice favours the latter form of vibration while the Americans have made considerable progress using the higher frequencies. This method of piling has two main advantages. Firstly, it is practically noiseless and, secondly, the speed of driving is increased, sometimes spectacularly. For instance, in one trial, a conventional rig took 21 minutes to drive a 71 ft pile while a vibrating rig took

42 seconds to drive a similar pile, a ratio of 128 to 1. The disadvantage of this method is that, to attain the high degree of efficiency, considerable dead weight is required on top of the pile. Vibration equipment has been found to be much more effective in pile withdrawal than the conventional extractors operating at lower frequencies.

Pre-fabricated Retaining Wall in USSR; Describes the construction of a precast reinforced concrete river wall, a mile long. One interesting aspect of the construction was the use of hydro-vibrators to consolidate the back-fill material.

The Wind Pressures on Buildings and Towers, (Part 1); Describes research into wind pressures with special reference to the duration of wind gusts and the time structures take to become fully stressed under wind loading. Such structures as television masts and Tower block buildings have very different characteristics to the average adopted in Code of Practice 113. This article gives data for obtaining the wind pressures for a wider field than the Code of Practice.

Thermic Boring: Describes the use of oxygen lances to bore through and cut concrete. The lance consists of a steel pipe packed with mild steel rods and fed with oxygen. When the end of the lance is heated to ignition temperature and the supply of oxygen turned on, a continuous oxidation reaction results. The heat of this reaction is sufficient to melt the concrete and reinforcing bars. The advantages of thermic boring over pneumatic tools are the absence of noise and vibration and low capital cost.

Drilling through Reinforced Concrete, (Part 2); Completes a description of the use of lightweight diamond drills for drilling through reinforced concrete. The main advantage of this method is that holes can be drilled through concrete in confined places with a high degree of accuracy.

Chepstow Railway Bridge Reconstruction, (Part 2): Completes the description of the reconstruction of Brunel's railway bridge across the River Wye. The specific problems dealt with in this part are the launching of the new girders, jacking up the new girders and the de-stressing and removal of the old trusses.

D.F.M.

Notes from *Civil Engineering and Public Works Review*, for March 1963

Rate of Settlement of a Clay Layer due to Gradually Applied Load: This article gives a theoretical solution for the rate of settlement of a building due to the consolidation of a thin layer of clay located above an impermeable stratum and below a permeable stratum. Drainage is only assumed to occur in the vertical direction. Comparison of results with the graphical method due to Terzaghi & Fröhlich shows agreement for values of time factor less than ·2, but for higher values the graphical method slightly overestimates the degree of consolidation.

The Wind Pressures on Buildings and Towers: The collation of meteorological records, and other published information, with a view to determining the behaviour of wind on structures was dealt with in the February issue of "Civil Engineering". This second article goes on to derive new design equations and tables for the effect of wind on structures. A design sequence is suggested involving the determination of the gust duration, return period of the wind with regard to the type of structure and its expected life, and the appropriate pressure taking into account the region and terrain grouping of the site. For design purposes this pressure must be multiplied by a shape coefficient dependent on the plan and size of the structure.

Developments in Structural Steelwork: The subject of recent advancement and development in structural steelwork was dealt with in an article by Major J. C. Peacey, AMICE, RE, in the March 1963 issue of *The RE Journal*. This article discusses the introduction of Universal Beams, High Yield Stress Steel, Castellated construction, high strength friction grip bolts, improved automatic welding techniques, and new design methods. A look is made into the future trends of structural steelwork; the use of electronic computors into problems of detail dimensions and rigid frame analysis; the greater use of automatic and semi-automatic welding processes; greater use of high yield stress steels; composite construction in buildings; elimination of moment connections due to utilization of floors as horizontal girders to spread wind loads in high building frames; and the use of steel in shell roofs, being some suggested spheres of probable developments.

HIGH YIELD STRESS (WELDING QUALITY) STEEL: This article pinpoints the considerable economic advantages that can be obtained from the use of the new high yield stress (welding quality) structural steel which is gradually and progressively replacing mild steel to BS15. This steel shows an increase in allowable stresses of 38 per cent in bending, 42 per cent in axial tension, and 42 per cent in axial compression, compared with those for mild steel to BS15: 1961. The extra cost of sections in high yield stress steel is only 10 per cent over that of mild steel, and when related to the cost of fabricated steelwork, this figure reduces to an increase of only 6 per cent. The adoption of the new steel in beams results in a substantial reduction of self weight in design, so that the actual cost economy can be as high as 20 per cent. When used as columns the increased load capacity ranging from 42 per cent at L/R = 0 to 4 per cent at L/R = 200 will cause a cost economy between about 20 per cent and 10 per cent. These economic advantages are creating a large demand for the new steel—a demand which is likely to increase as awareness of the new steel increases. Regular production throughout the full range of sections already exists.

THE PROTECTION OF STEEL STRUCTURES: The author briefly discusses the causes of corrosion and the requirement for protection against corrosion of various structures. The all-important subject of surface preparation is then covered, and methods ranging from the near-useless hand wire-brushing, through mechanical wire-brushing, flame cleaning, pickling, to the most effective method of shot blasting, are described. In the realm of paint protective films the various types of priming paints, undercoats, and finishing coats are described. Applied metal coatings such as zinc or aluminium are also discussed, and it is pointed out that although the initial cost of such a protective coating may be much higher than that of paints, such protection may well prove the cheapest over a long period of maintenance time. Two other articles on this subject mention the use of cathodic protection and recent successes in the field of plastic-coated sheet steel, respectively. In the latter instance, of course, much improved decorative finishes are also a distinct advantage.

STAINLESS STEEL IN CIVIL ENGINEERING; The tremendous variety of uses to which stainless steels have been, and can be, put, is often forgotten. In the field of general engineering it is widely used in dairies, breweries, textile plants. In the aircraft industry every turbine engine produced relies on the properties of stainless steel, and even in nuclear engineering it has now made possible the development of the Windscale Advanced Gas-Cooled Reactor.

In the field of civil engineering, stainless steel has been used in dam and reservoir construction, sewage disposal schemes, furnace structures in the cement industry, etc. Perhaps the most spectacular use of stainless steel so far devised is the dome of the Pittsburgh Public Auditorium Authority. This dome is of 415 ft diameter, consisting of eight openable roof leaves, each of which is sheated in stainless steel.

FRICTION GRIP BOLTS: This article is the first of a series reviewing the various design and assembly techniques of structural steelwork in relation to current research on friction grip bolts. The function of friction grip bolts (i.e. the transference of loads in connected members by friction between parts rather than by shear or bearing on the bolts or plies of the connected members) is explained. The article then goes on to consider the choice of the working stress in the bolt in relation to its material properties and to methods of preload control. In this preliminary article, some special bolts—the Self-reactor bolt, GKN Load Indicating bolt, and Waisted or Turned bolts—are also considered and their characteristics discussed.

PILE DRIVING BY VIBRATION: Part I of this article appeared in the February issue of the "Civil Engineer". This short second part merely extends the information given in the first by quoting several examples of recent use of sonic piling apparatus. The instances related are mainly of sheet piling and extraction work in Europe by certain French and German equipments. A British sonic piling machine is under development by the British Steel Piling Co., Ltd.

J.R.J.

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, December 1962

THE PIPELINE FLOW OF CAPSULES: The second and third pages of this paper (pp 26 and 27) have been transposed by the printer. During the past century the use of pipelines as a means of transportation has increased enormously with the development of oil and natural gas resources and, since the principal cost involved is that of the provision and installation of the pipe itself, it is the cheapest form of overland transport, comparable with water transport.

From the movement of fluids and gases, the transport of solids in suspension has been successfully developed, but commercial application is at present very limited. *The Engineering Journal* published two papers on this subject in June and August, 1961 (see *R.E. Journal*, December 1961).

This paper discusses the use of capsules, an idea inspired by the formation of slugs of oil in water, for the pipeline transport of a much wider range of materials, such as grain, minerals, and chemical products. Capsules, probably made of a disposable film material, would be either spherical or cylindrical in shape, with a diameter of about 90 per cent of that of the pipeline. A common carrier pipeline handling a variety of bulk commodities might, at least in Canada, prove economically advantageous in the absence of competition by water transport.

SETTLEMENT STUDIES, MT SINAI HOSPITAL, TORONTO: The Mt Sinai Hospital is a steel-framed multi-storey building carried on a reinforced concrete mat foundation on a subsoil of glacial till. This paper describes a 10-year programme of settlement investigations. These reveal that there has been unexpectedly little movement, and point to some conclusions of value to specialists in soil mechanics.

LOSS MEASUREMENT IN MAGNETIC STEEL: This is a paper for specialists. It describes a method of measuring losses in steel at saturation flux density, which is of importance primarily in the design of electrical machinery.

Notes from *The Engineering Journal of Canada*, January 1963

FORM DESIGN FOR HIGH LIFTS: The author of this short paper draws attention to the lack of practical information about the design of formwork for massive reinforced concrete structures, and records his own method of design, with two examples. He considers the ruling factors to be the maximum pressure exerted by the wet concrete and the rate of pour, since he concludes that pressure need not be taken into account after initial set has taken place. No details are given about the mix proportions used, but the concrete is described as "very liquid, with a minimum slump of 6 in", and it was placed by dropping a distance of up to 20 ft, "causing a very strong impact". There is no mention of segregation, which might be anticipated in such circumstances.

PATENTS—ANOTHER ENGINEERING TOOL: Fourteen basic questions and answers provide a useful and interesting background to the subject of patent rights. The potential inventor, while he may be encouraged to seek a Canadian patent, should realize that some of the details here given do not apply in the United Kingdom.

RAIL VEHICLE NOISE: A very interesting paper on noise abatement was published in *The Engineering Journal* of December, 1959 (see *R.E. Journal*, June 1960). The present discussion deals in greater detail with a more limited problem, and one which affects not only the passenger but also the near-by resident. The former has some vested interest in noise that is getting him somewhere: the latter feels nothing but hatred of trains in his bedroom. The two viewpoints demand different methods of alleviation.

COSTS OF ELECTRIC ENERGY IN BRITISH COLUMBIA: Costing and estimating are not subjects of universal appeal, but this paper includes much information of general interest. The startling effect of cheap power in an area ripe for industrial development is shown by the findings of a Royal Commission on Canada's economic prospects, whose report states that, for every dollar spent on a new hydro-electric project, two dollars have gone into industrial construction, and that, for every employee engaged by the power companies, fifty men have found jobs in secondary industry.

Notes from *The Engineering Journal of Canada*, February 1963

THE EFFECT OF EXTERIOR BUILDING CONSTRUCTION UPON THE COST OF HEATING AND AIR CONDITIONING SYSTEMS: Any practical engineer is aware that the extensive use of glass in outside walls leads to excessive heat loss from the building in cold weather, and to unwanted solar heat gain and glare in hot weather. This analysis of the initial and annual costs of heating and air conditioning, dependent upon the heat transfer coefficient of walls and roof, is based on dollar costs per square foot and on climatic conditions inapplicable in the United Kingdom, but it should help architects and others responsible for the design of schools and office blocks to appreciate the economic effect of glass and steel façades. Buildings are intended to create an environment within which man can live and work in comfort, and they should provide a thermal as well as a physical barrier between that environment and inappropriate conditions out of doors.

ANALOG COMPUTER SIMULATION OF SHIP PROPULSION SYSTEMS: A brief description of the analog computer is followed by an account of its application to the study of a diesel-electric ship propulsion system. This paper provides mental exercise for the technically minded.

PLOTTING UNDERGROUND PUBLIC UTILITIES IN THE CITY OF OTTAWA: There are more than 1,400 miles of underground services below the streets of Ottawa, comprising pipes from 6 in to 6 ft in diameter and conduit up to 3 sq ft cross-sectional area. The mileage has almost doubled in the last ten years, and development will lead to steadily increasing demand. Before 1960 there was no co-ordinated plan showing all services in relation to each other, and the records of the separate utility companies and city departments were often incomplete or of doubtful accuracy. This led to unnecessary difficulty and expense in the planning and execution of new projects. A joint committee of all interested parties was set up, and the production of large-scale comprehensive plans is in progress. The methods being used are described, and the main lesson is, perhaps, the value of the mutual confidence established between the various utility authorities. Similar action is undoubtedly desirable in some places in this country.

AUTOMATION THROUGH THE ON-LINE PROCESS CONTROL COMPUTER: This paper describes the characteristics and capabilities of the latest member of the family of high-speed digital computers, which can receive data direct from a process to which it is applied, and control the process operation by output signals. The system must be specifically designed for application to a particular process, and the author gives an interesting example. This method bids fair to revolutionize the development of automation.

R.P.A.D.L.

THE MILITARY ENGINEER

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Man in Planetary Operations, by Albert A. Glass: Man's part in space flights is to serve three functions; he will be a scientific specimen, a scientific observer, and a functioning component within a space system. The astronaut will add to the reliability of the system and provide flexibility for conditions which were not anticipated prior to his flight. His exact role will depend largely on skill in predicting the capabilities of man and machine in space, and how man actually behaves in space for extended periods of time. The author of this article is a senior human factors engineer at the American Machine and Foundry Company where he has studied problems of orbital launch operations, space tools, and human needs in flight, and has participated in a weightless flight for first hand information and experience. In it he describes at some length the immense amount of research which is necessary, and being undertaken on the purely human aspect of space travel which is essential before a space craft can be designed and equipped which will enable human beings to maintain life and efficiency and be able to perform the functions described at the beginning of this note.

Engineer Combat Effectiveness.—Electronics on the Battlefield, by Major Edward R. Hindman. Corps of Engineers U.S. Army: This article gives a fairly full description, without design details, of various new equipments available or being developed for the U.S. Engineers. They are (*a*) Night Viewing Aids, including an improved conventional searchlight, infrared searchlight, and equipments making use of infrared and heat emanations of the objects viewed which require no power emission from the viewer. (*b*) New non-metallic and metallic mine detectors and notes on the progress which has been made in the remote detection of mine fields by photographing from the air, using specially designed combinations of films and filters. (*c*) Electric generators: these are conventional in principle but a wide range is available with increased reliability and with reduction in size, weight and number of types and sets. The article is well illustrated.

Elephants and People Power, by Lieut-Comdr Malcolm T. Mooney. Civil Engineer Corps U.S. Navy: An interesting well illustrated article on the old methods employed by building and engineering contractors in South-East Asia working on the Military Assistance Program. The author has to admit that in a country where there is a large labour force the old methods have distinct advantages.

Military Engineer Field Notes

Carrying Water to Remote Places, by F. C. Livingstone: This is a description of the supply of water in sufficient quantities for irrigation, to the islands of the Cyclades by the use of specially made Dracones. A Dracone is a neoprine-coated nylon cylinder which was designed for the water-borne transport of petrol or oil. This idea has been adapted for the transport of water, units conveying 1,000 tons have been used. There is an obvious military application of this method.

Floating Dock for Polaris Submarine, by Lieut-Comdr William E. Nims, Civil Engineer Corps, U.S. Navy: A well illustrated description of the design and installation of the floating dock at the Polaris submarine base at Holy Loch.

Universal Engineer Tractor, by M. R. Bennett: A description of the vehicle now under test by the army engineers. There are good illustrations and specification details. The vehicle is truly versatile, the article claims that "It will operate well on bulldozing, grading, earth loading and hauling, it can load, haul and unload cargo and is also a troop carrier and a towing tractor of considerable performance range. It is air transportable as well as amphibious, and it has a suspension system permitting high cross country speeds with tractive ability suitable for a construction tractor." The photographs certainly bear out the claims. No cost is given.

FOUNDATION STABILIZATION TECHNIQUE BY VIBRATION, by Lieut-Colonel Tom H. Reynolds, Corps of Engineers U.S. Army: This article describes with technical details, diagrams and photographs the method employed to provide stable foundations under the complex being constructed at Cape Canaveral for the launching of the third series vehicles of the Saturn Rocket Program. The use of pile foundations was not considered practical since no adequate bearing stratum exists at an acceptable depth. A vibration and floatation method of compacting cohesionless soils into columns was therefore selected.

MILITARY DEMOLITION RESEARCH WITH CIVIL WORKS, by Howard J. Vandersluis: The need to demolish a series of locks on the Ohio River provided an opportunity to carry out a series of tests of various theories of under-water demolition of concrete structures and other demolition techniques. In particular the use of millisecond delay caps both in concrete demolitions and for cutting steel. In one case as many as sixty-nine charges were fired in a single shot, but the rows were timed to explode at intervals of from 8 to 75 milliseconds.

THE LEWISTON–QUEENSTON BRIDGE, by Samuel Elder: This bridge across the Niagara River half a mile north of the Canadian and American hydro-electric generating stations was opened to traffic in November 1962. It is a single steel arch bridge. The arch is 1,000 ft long with a rise of 159 ft. Its centre is 370 ft above the river. It is the largest bridge of its type. The article describes the design and erection of the bridge in a very clear and interesting way. There are excellent photographs and a diagram.

MILITARY CONSTRUCTION AID IN IRAN, by Colonel Edward L. Waddell, Jr, Corps of Engineers U.S. Army: A brief sketch with interesting illustrations of the construction of army cantonments in Iran under the direction of the Corps of Engineers. There is a summary of the work being carried out by the Engineer Corps in Iran which includes a base for the Imperial Iranian Navy in the Persian Gulf, two jet airfields, not to mention Hamadan Airport which is in operation, a large number of gendarmerie posts and military accommodation of all kinds.

J.S.W.S.