Hatt

THE ROYAL ENGINEERS JOURNAL

Vol LXXXI JUNE 1967 No 2

CONTENTS

PUBLIS ... RS

AGEN

4,000 1.6.67

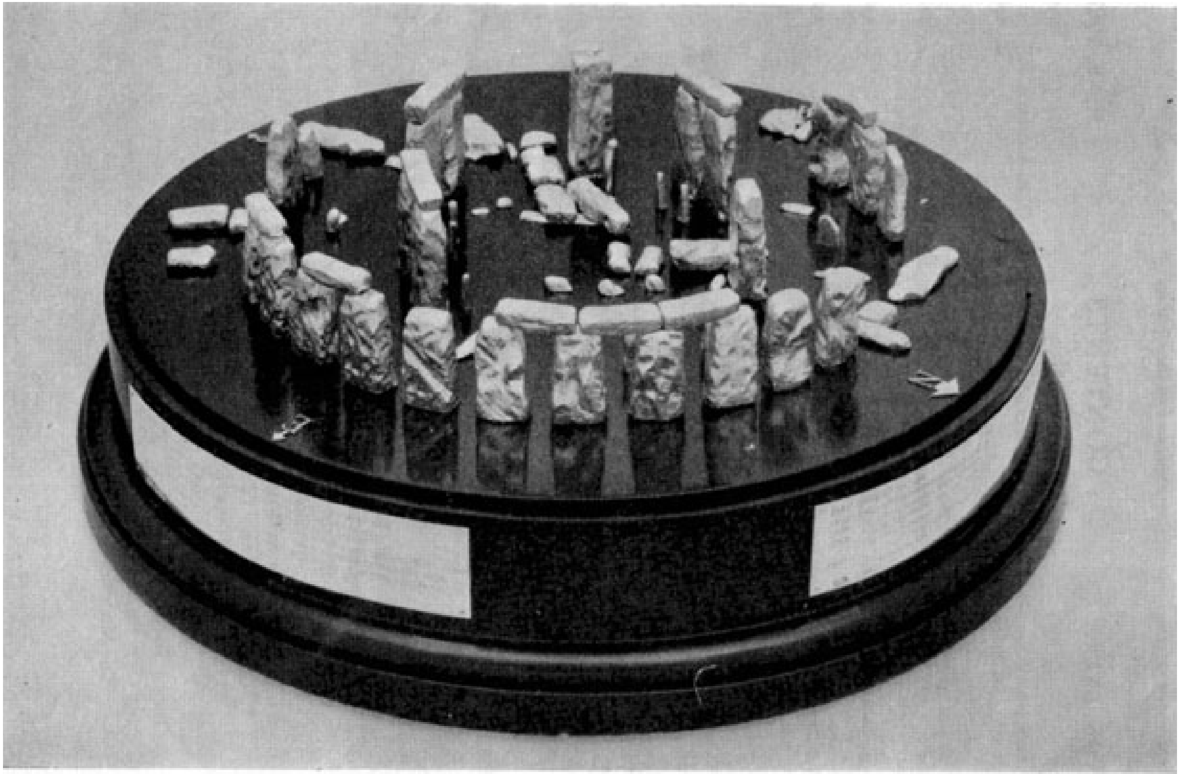
THE ROYAL ENGINEERS JOURNAL

Authors alone are responsible for the statements made and the opinions expressed in their papers

VOL. LXXXI

CONTENTS

JUNE, 1967



The Centrepiece

Stonehenge- A Corps Centrepiece

Stonehenge—A Corps Centrepiece

By Lieut-Colonel C. A. Landale, RE

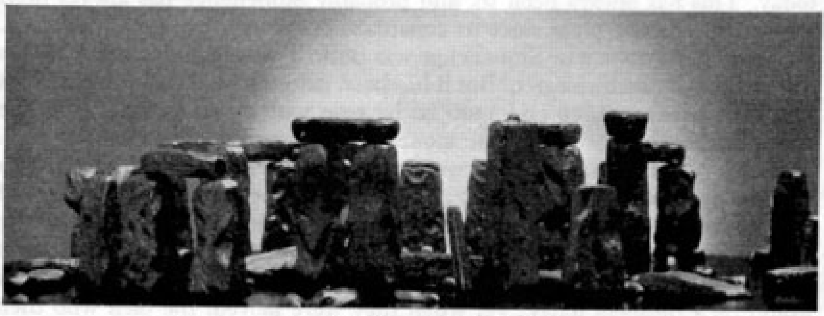
An unusual and imaginative silver centrepiece has recently been acquired for the Corps of Royal Engineers. This centrepiece, depicting Stonehenge as it stands today, is to be kept by 3 Division Engineers who are at present stationed in Tidworth. Royal Engineer units have been stationed on the "plain" for upward of sixty years, almost without a break. The comings and goings of these units would take long to relate, and is in any case not pertinent to this article. Suffice it to say that there has been a constantly recurring association of Sappers with Salisbury Plain and these Sappers have deployed to the four corners of the world to take on engineering tasks which have taxed the ingenuity and determination of everyone concerned. More recently 3 Division was organized to provide a strategic reserve for the British Army. Its Sappers, 22 Field Engineer Regiment, became 3 Division Engineers. Their history has not been written, though no doubt it will be some day, but the Sapper of today serving in 3 Division cannot but be conscious of this long association with Wiltshire and with Salisbury Plain.

Salisbury Plain is one of the better known features of English geography today. This has always been so, and probably Stonehenge has always been associated with the plain since its construction started over 3,500 years ago. No one really knows why Stonehenge was built. This remains a puzzle to this day in spite of much research. But it has been determined that this monument was built between 1800 and 1400 BC by men with no tools other than the bones and antlers of deer. The stones which comprise Stonehenge weigh between 7 and 45 tons. They were moved either from the Marlborough Downs, where outcrops of Sarsen sandstone could be found on the surface of the ground at that time, or from South Wales. In this latter case the harder "blue stones" were moved by land and water a distance of some 240 miles before being positioned on their present site. The movement of these stones would be a problem today; yet when they were moved, the men who then lived had no mechanical aids at all. Their effort was a simple—but gigantic—piece of field engineering. Undeterred they slowly achieved their object. Over the centuries the design of Stonehenge was changed and reviewed. Subsequently it was left to decay and only today has that decay we hope been halted. Stonehenge and Salisbury Plain are now synonymous.

The centrepiece depicts the main Sarsen circle which is about 100 ft in diameter. Originally this circle consisted of thirty uprights, each of which weighs about 25 tons, capped by thirty lintels. Within this were erected five trilithons, each of which consisted of a massive lintel, supported on two 45-ton uprights. Standing inside the Sarsen circle is the now very incomplete blue-stone circle and, within that, the blue-stone horseshoe at the focus of which lies the Altar Stone. This latter stone, though of sandstone, came from South Wales in the area of the Prescelly Mountains. The movement of this stone alone, overland to Milford Haven, by sea to Avonmouth and thence by the rivers Avon, Frome and the Salisbury Avon to Amesbury remains an outstanding achievement of ingenuity and determination.

The origins and purposes of Stonehenge have always been a matter of great speculation. As early as the twelfth century, Geoffrey of Monmouth, a writer of his day, declared that it was a monument to British warriors treacherously slain by Hengist and Horsa. Another common view at that time was that Merlin had "magicked" the stones from Ireland, while a widely held and popular modern view is that this monument was a Druid temple. There is, however, no justification for any of these views, and it has now been established that the monument was built between 1800 and 1400 BC, long before the Druid priesthood became established in this country.

It appears likely that the monument, built by stone-age people who were sun and moon worshippers, was not only a monument but also an astronomical calendar. It was first noted in 1740 that the main axis of Stonehenge is aligned to sunrise on Midsummer's Day. More recently measurement data fed into a modern computer (an IBM 7090 for the technically-minded) indicates that each significant stone lines up with at least one other to mark all the extreme positions of the sun and moon throughout their cycles. Also by using the Aubrey Holes (outside the scale of our model and invisible today to the casual visitor) calculations can be made to determine future eclipses of the sun and moon. This suggests that the whole monument was, therefore, a complex and efficient astronomical calendar. The positioning of the stones may be coincidental, but there is much to suggest that the latest theory may be nearer the truth than some considerations of the past.



Representation of the Sun rising behind Stonehenge

The Sappers of today, particularly those of 3 Division Engineers, are prepared to move at short notice anywhere in the world. The dictates of modern politics demand that they fly and take with them the minimum tools and machinery. Their task will never be another Stonehenge, but they will have to use all the principles of elementary field engineering. The simplicity of the model, and the original on which it is based, may serve as a fitting reminder that any military engineer's task is to overcome difficulties in the most simple and direct way available to him.

Construction of Deployment Camps Aden 1962 to 1964

By LIEUTENANT-COLONEL D. N. LE GASSICK, RE, FPWI

BACKGROUND TO ADEN

THE Aden State as it is now known has an area of about seventy-five square miles. Aden consists of two rocky peninsulas, Aden and Little Aden, some twenty miles apart and connected by a good bitmac road. In 1928 Aden became an Air Command and remained basically so until 1959 when a Combined Headquarters was set up for the Middle East. As a staging post to the Far East, RAF Khormaksar became one of the largest air stations in the world and Aden one of the largest oil bunkering ports. In 1962 with the forthcoming Independence to Kenya new facilities were needed in the Middle East and Aden was chosen for the deployment of additional Troops. As the reader will now know South Arabia is to become Independent in 1968 with the centre of Government in Aden. Public facilities will become the property of the new Government together with the facilities constructed during the period of this article. The permanent barrack blocks and other installations will be of lasting value to the emerging government and its regular army which does not possess adequate facilities at present. The Twynham hut used in the camps was designed to be dismantled and re-erected as needed and a large number have already been moved to Bahrein and elsewhere in the Middle East.

INTRODUCTION

In 1962 the Quartermaster General visited Aden to consider the construction of the additional camps. He was followed by the Engineer-in-Chief who offered Engineer assistance in the construction of the camps. This would be in support of the Air Ministry Works Department, who were absorbed by the Ministry of Public Buildings and Works in 1963. The AMWD readily accepted this assistance; their supervisory capacity being limited and the local building potential already working to full capacity. In April 1962 a Specialist Team, RE was sent to Aden to assist the AMWD in the planning. The overall requirement was to construct four major camps, two in Aden and two in Little Aden. In 1963 the CRE was asked to take on the extensions to the Cantonment in Little Aden, so in fact the equivalent of five major camps were to be built. The designs for the camps in Aden had been completed and the main task for the team in Little Aden was to survey the two re-entrant sites for Salerno and Anzio. The camps, Salerno, Anzio and Mandalay lines in the Cantonment; the Transit and Normandy camps in Aden, were all to be completed, at least to a "get you in" stage, by December 1963 and completed by December 1964. The CRE also took on the construction of the Jebel road in Little Aden which joined Salerno and Anzio with the Cantonment.

Early in 1962 the construction of the Cantonment was already in hand. This was of considerable extent and included permanent barrack blocks, messes, married quarters and other facilities for three major units. The work was under the supervision of AMWD, at an approximate cost of £7 million and continued at the same time as the deployment camps under the CRE.

DEPLOYMENT CAMPS.

OUTLINE PROGRAMME FOR COMPLETION.

WORK BY ENGINEERS ONLY.

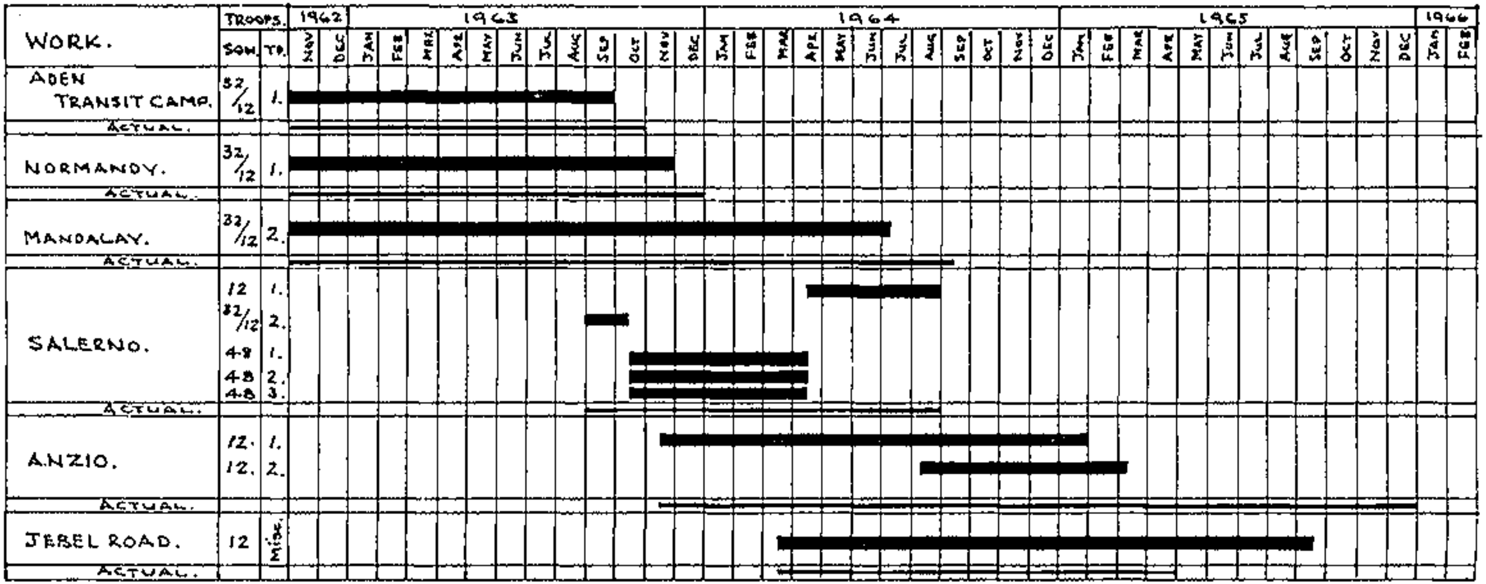


Figure 1

This article describes the work for which the CRE was responsible and some of the problems.

Work of the Specialist Team. The team surveyed the two re-entrant sites, situated on the northern side of the Jebel Am Muzalkan, for Salerno 150 acres and Anzio 100 acres. The surveys were completed in about six weeks, during April and May, two of the hottest months of the summer season. A plan, scale 1/500 was made with contours at 5 ft interval, also a plan 1/2500 scale on which the camp layouts were designed by the OC Specialist Team, who later, was appointed CRE Deployment Camps. The camps were designed keeping the sub-unit (company or battery) in complexes, each separated by the camp roads which were set at a lower level to act as run-off drains. Monsoon type wadis were also included to carry surface water from the sides of the Jebels.

The team then prepared detailed lists of the project stores required which were sent to the AMWD who were responsible for the financial control of all the projects. A list of plant and equipment needed was also prepared and sent to the Ministry of Defence who arranged shipment. New Twynham huts were to come from the United Kingdom and the balance was made up of second hand huts from Cyprus and East Africa. AMWD ordered other project stores to the value of £0.75 million before financial approval was given, in particular timber, air-conditioning units of all sizes and kitchen equipment, and these began to arrive in September 1962. In June, events slowed down as approvals were being delayed, this was frustrating for the team and the personnel waiting to be called forward. In September 1962 approval was given for the transit camp in Aden and as sufficient huts had arrived, it was decided to commence the erection of huts at Normandy as well but by the time work began in December, approval had been received. An outline works programme was now produced, Figure 1, on which all the planned work was shown. The detailed programmes at each site were made by the Garrison Engineers in charge.

The team also prepared the special establishment for the CRE staff and this is shown at Appendix 'A'. Records and AG 7 were involved in much work in getting together the personnel for the project. The majority came from the United Kingdom but two came from East Africa and they began to arrive in October and had all arrived by January 1963.

Supervision and Labour. The CRE was responsible for the construction of the camps, with Engineers, Pioneers and local labour constructing the huts, bases, roads and other external work. The permanent buildings in the camps were built by contract under his supervision. Each project was controlled by a Garrison Engineer with a staff of Clerks of Works, construction, mechanical and electrical. Their task was to supervise and co-ordinate the Engineer work and then the contract, which followed at four of the sites. The Quantity Surveyor and his staff of two NCOs, supervised the CRE work under the Chief Quantity Surveyor, AMWD, later MPBW.

The standard Field Squadron was chosen as the basic working unit, whose tour in Aden was twelve months unaccompanied. 32 Field Squadron was the first to be employed on the work but the squadrons which succeeded them, arrived with additional tradesmen particularly, carpenters and electricians held against their field engineer strength. It was also agreed that two troops would be employed on the projects, with one troop at a time, engaged on up-country tasks. This gave the men a change of scene and a break from the humidity in Aden. The rest of the labour force included three sections of Pioneers, fifty-four men and up to 350 local labour, with some tradesmen, provided under a separate contract. Throughout the work the force was organized into teams, of one Troop RE, one section of Pioneers and sixty-five to eighty-five local labour. This was flexible and was often changed to suit the needs at a site.

The Twynham hut and air-conditioning. The standard hut described in this article is 64 ft long but there is reference to half and quarter huts, 32 ft and 16 ft long and at most sites, a number of 96 and 128 ft huts were also built. All the huts erected for living and office accommodation were air-conditioned. It is not intended to go into much detail in this article, as the author published an article on the subject, under Section 15 of the RETN, dated September 1965. This describes the tropical hut and the work and modifications necessary, to fit the 5 and 8 ton package units and the smaller, ½, ¾, and 1 ton window units. Briefly, the package unit consisted of an air handling unit and a refrigerator unit, sited at the gable end of the hut. Warm air was extracted from the hut at floor level and cooled air was blown into the hut, through grills set into a false ceiling. The false ceiling was built into the apex and along the length of the hut, it was constructed in timber and covered with soft board. Fitting the smaller units involved somewhat less work. The unit was fitted into the side of the hut, under a window and the internal and external cladding was cut to size. A timber frame was then fitted between the wall rails and the unit fitted into the frame and the cladding made good around.

Electrical work. All the internal wiring for the huts—for lighting, bedhead lamps and the 60 in sweep fans—was done by Engineers. They also made the connections from the mains supply to the air-conditioning units. At first, surface wiring was used and this occupied four electricians five days to complete one hut and a speedier method was needed. A Clerk of Works designed a standard harness for the 64 ft hut and it was such, that modifications could easily be made to suit any hut, including those with partitions. The harness was usually made up on the ground or on a hut base. The runs and drops were marked out and control points to switches and junction boxes fixed. Cables were marked with coloured tapes, then bound together and the whole harness wound on to a bobbin and stored until required. The harness was fixed to the hut frame before the internal cladding and ceiling was fitted. It could be made under the supervision of an A III electrician, with unskilled labour, in 6 hrs and fitted into the hut, by one electrician and two labourers, in 4 hrs. This proved most successful and was adopted for all huts erected in Little Aden and in completing huts at Normandy.

Aden Transit Camp

Work began on this first camp on 15 October 1962. The camp was designed to accommodate two battalions in tentage on concrete bases, with kitchens and ablutions in semi-permanent construction. The living and office accommodation for the permanent staff would be in Twynham huts and other facilities including a combined mess for all ranks of the staff, Junior Ranks Club and ablutions would be built by contract. The site was situated north of RAF Khormaksar, partly on unstable sand, with its entrance off the main road from Aden to the Arab town, Sheikh Othman, with the sea 400 yds to the east. The project was bedevilled by a shortage of money and

Photo. 1. Aden Transit Camp. From the east with tent base area in the centre. Permanent staff quarters on the left and transit facilities on the right.

Construction Of Development Camps Aden 1962 to 1964 - 1 the scope was much reduced; in addition to the work agreed, Engineers took on the construction of the three transit kitchens and two Romney sheds. In reducing the scope a number of desirable items were cancelled but the largest single item was the omittance of tent bases for one complete battalion. If needed, tents would be pitched on the sand and subsequently when the Radfan operations began in 1964 and extra units arrived, both areas were kept in full use.

No main sewage system existed in the area and owing to the financial restrictions the consultants were forced to design large soakaway pits, with 9 in stone filling, adjacent to kitchens and ablutions. The water table was about five feet and although violent objections were raised by the CRE, supported by the Chief Engineer, AMWD, no extra funds were made available and the scheme went ahead. Fears were justified within four weeks of the camp being occupied when they overflowed and had to be pumped out daily by sullage wagons. A drainage scheme was then designed at a cost of some £54,000 and approved in 1964.

The project. The over-all approval was for £197,800. The B and CE contract was £56,000 and value of stores for incorporation by Engineers was approximately £30,000. The balance was in the electrical contract, air-conditioning units and the 80,000 gallon high level water storage tank. The division of work was:—

Work by Engineers

a. Twelve Twynham huts; four as offices and eight for quarters and messes.

b. Total of 120 concrete bases.

c. Roads, kerbs and MT area.

d. Two Romney store sheds.

e. Three kitchens for transitees.

f. Security fencing and sports fields.

Work in the contract

a. Junior Ranks Club.

b. Combined kitchen for permanent staff.

c. Two ablution blocks and two large camp structure type ablutions in the transit area.

d. Small arms store.

e. High level water tank.

f. Perimeter security lighting.

Concreting

To avoid any delay in starting work, minimum site preparatory work was done and a batch mixing plant was not set up on site. Because of the unstable sand the bases were cast 5 in thick on 6 in of hardcore. The hut base was divided into six bays and three bays were cast daily and the hut verandah cast in two sections. The aggregate was of poor quality and a fair finish to the surface was difficult to obtain. Also, there was no piped water available on site for several months and water was delivered by bowser and trailer, this also affected the curing of the bases and later some surface cracks appeared. A total of 120 concrete bases were cast of which ninety-nine were for the 30 × 20 ft MUG tent. Steel road forms were also used for the shuttering and after being set in position, the enclosed area was filled with hardcore and a 4-in slab cast on top. A timber post was set into the centre of each base, to which electric outlet sockets were fitted and this provided the supply for lighting and fans in each tent. Bitmac surfacing of the area around the bases was an item omitted and the high winds in August caused some scouring and discomfort to the occupants.

Twynham hut erection. Nine of the twelve huts were air-conditioned and fitted with the false ceiling, there were also a number of partitions and internal doors fitted into store huts. There was a problem with the installation of the trunking for the 8-ton units; owing to an error on the hut base plan, it was delivered 2 in too long and had to be shortened and the flange re-rivetted. Initially this also occurred at Normandy and involved a good deal of extra work. Later, this problem was easily overcome by lowering the level of the plinth in relation to the hut base. After erection the trunking was insulated with two 1 in thicknesses of cork on bitumen and was a tedious task.

Transit kitchens and Romney sheds. The three kitchens were scaled for sixty officers, 150 NCOs and 1,200 rank and file, with dining tents pitched alongside them, on bases. The walls were constructed with hollow building blocks, with concrete floors. Timber trusses were made up on site for the roofs, to take asbestos sheeting but supply was delayed and Twynham roof sheeting was used and hut windows and doors also built in, to save time. Engineers installed the cooking equipment, plumbing and water supply. The equipment was served by Butane gas, supplied by British Petroleum under a separate contract. The whole task was a formidable one but with the assistance of some local masons the Sappers finished the task ahead of the main contract.

Roads and fencing. Roads were 20 ft wide with a 4½ in flush kerb, cast in-situ, made up timber shuttering was used and the target for laying was 200 FR per day. The roads were built with 6 in of hardcore, hand packed and the surface was finished with 3 in of scree, rolled and watered. In reducing the scope the bitmac surfacing was omitted, however, later the main through road was surfaced leaving other areas unsurfaced. The fencing consisted of 8 ft reinforced concrete posts, supplied by contractor who cast on site. Spacing was at 9 ft centres, with plastic covered chain link fencing. Erection was carried out by Pioneers at a rate of 500 FR per day.

The contract

The contract was let to a local contractor on 22 January 1963 for completion in six months. This was extended to include the high level water tank. The erection of the tank had to be entirely supervised by a Clerk of Works and was complicated by the fact, that before being despatched, all sections had been repainted obliterating the section numbers. The plates had to be sorted and renumbered before erection could start. This was our first experience of working with a local contractor. The lack of an English speaking site agent made supervision and co-ordination of the work difficult for the works staff. Errors were discovered in the contractors' stores ordering from overseas which later caused delays. These lessons were learned the hard way and on subsequent projects, Garrison Engineers always had copies of the contractors' stores orders for checking against the bills of quantity. The Garrison Engineer virtually took over the co-ordination of the contract which was finally completed and the camp handed over in November 1963.

Photo. 2. Normandy Camp. View from the east, showing some huts and Rank and File dining-room under construction.

Construction Of Development Camps Aden 1962 to 1964 2

Normandy Camp

Work began at Normandy in December 1962. It was designed as a Garrison minor units camp to accommodate two GT Companies, then RASC, one Pioneer Company and a Field Survey Squadron, RE. The site was on the Isthmus between Aden and RAF Khormaksar airfield, with beach and sea 200 yds to the east. The site was level on firm sand with the water table at about 6 ft, the small amount of excavation needed, was mostly done by hand. Electric mains supply was available from the adjacent married quarters area and connexion easily made into nearby sewage. There was adequate piped water supply for construction and the PWD were in process of laying a new main from Sheikh Othman to Aden, past the site and a connexion was made for the permanent supply.

The site was the old reinforcement camp still partially occupied by the camp staff and a regiment, RA. Accommodation existed in tentage on concrete slabs which had to be removed before construction could begin. Electrical fitting for lighting and fans also had to be dismantled but the kitchen in semi-permanent construction had to remain, until the new kitchen and dining hall had been built under the contract. Assisted by the camp staff, a fairly steady supply of building sites were cleared and alternative accommodation found for the occupants. However, progress was not smooth and frequently effort had to be diverted to other tasks in the programme. The problem solved itself in August when the Regiment returned to the United Kingdom.

Preparation of the site for construction began in November 1962 and was completed in six weeks. During this time, the resources compound was fenced in and was ready to receive the project stores which began to arrive in December. Electricity was laid on to the site and the workshops installed near the resources compound. A concrete batching plant was also constructed, with three high level storage bins, two for aggregate and one for sand and the mixers were fed from the bins. A 19 RB was placed so the bins could be kept filled from the stock piles in the rear.

Plant and Workshops

Appendix 'B' shows the list of items of plant held for the work. It was held by the CRE and operated by the Squadron employed at the time. Initially the Squadron was not fully manned and unable to control the relatively large number of items. This was overcome in June when the attached Park Troop was brought up to strength in fitters and operators. Plant in daily use on the sites included 14/10 concrete mixers, $\frac{1}{2}$ cu yd dumpers, Michigans, Drott and road rollers. The workshop was first set up at Normandy and was subsequently moved from site to site as the work load changed. Its main task was to prepare timber and prefabricate items for the sites. A Clerk of Works Mechanical supervized the shops with a team consisting of carpenters, welders and blacksmiths from the Squadron and six local labour. Temporary cover was built over the working areas to afford some protection from the sun. A large quantity of items were produced for the sites and prefabricated items helped to speed construction.

Resources. The resources compound also first set up at this site was moved as the work load changed. The Resources officer had a staff of a warrant officer, three sergeants, storemen and some local labour. One sergeant was attached to each Garrison Engineer at site and was the link with the Resources officer on all stores matters. He alone authorized local purchase and worked closely with his opposite number in the AMWD stores branch. He was also responsible for ordering and controlling all project stores and the "A" tools. The organization worked successfully and contributed to a large degree in maintaining the progress at the various sites.

The project. The tasks to be carried out by Engineers were:—

a. Accommodation and offices	47½ Twynham huts
b. Roads: 20 ft wide	1,000 FR
15 ft wide	2,500 FR
Concrete kerbs	9,000 FR
c. Fencing	2,500 FR

The batching plant produced an average of nineteen mixes per hr from one mixer and during a 5-hr day, 35 cu yds of concrete, this was almost twice the output at transit camp. The first hut base was laid on the 10th and the first hut erected on 21 January. The bases were cast as at transit camp but prior to concreting the base, hollow building blocks were set in at 8 ft centres, for the column holding down bolts and concrete poured round them and during erection the bolts were grouted in. This was found to be easier than withdrawing wooden cores. Owing to a shortage of road forms, kerb blocks were cast at this site and laid at 200 FR per day.

The standard hut was constructed with one verandah, two doors and twelve windows and to conserve space in the Officers' and NCO lines, two 96 ft huts were built. Apart from the false ceilings built into the living huts, a large number of partitions and internal doors were also built into offices and stores. The work was straightforward but slow due to a shortage of tradesmen and the poor quality of the timber. Almost as much effort was required for this work as in the erection of the basic hut. To meet operational needs, resulting from the Radfan operations, the huts were handed over as they were completed.

The contract. The overall approval sum was £386,000. The contract for the B and CE work was let on 26 November 1963 at £150,000, for completion in six months but with variations and additions this rose to nearly £200,000 in July. The balance was in the cost of stores for incorporation by Engineers, £145,000 and other stores. A separate contract was let for the M and E work. The buildings in the contract included:—

a. Officers and NCOs messes and kitchen and dining hall for R and F.

b. Junior Ranks Club.

c. MT area, including; two GT sheds as garages, offices, stores and workshops, seven ramps and washdowns, covered parking, hardstanding and POL point.

d. Ten ablution blocks.

e. High level water storage tank, 80,000 gallon capacity.

f. Dhobi Ghat.

g. High Marston shed as map store, increased for Naval chart store.

Priorities were laid down as follows:—

Unit	*Item*	*EDC*
1. Field Survey	Marston map depot	17 August 1964
2. All units	Kitchen and dining hall for R and F, some MT facilities and ablutions	17 August 1964

Photo. 3. Normandy Camp. The batch mixing plant in operation.

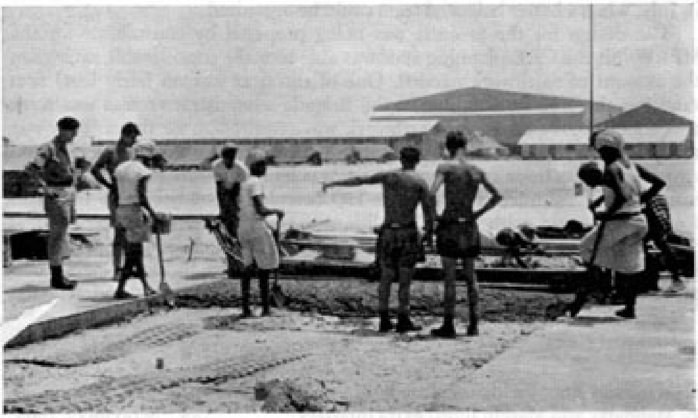


Photo. 4. Concreting hut bases at Normandy.

Construction Of Development Camps Aden 1962 to 1964 3 & 4

3. All units	Officers and NCOs messes	1 October 1964
4. All units	Junior Ranks Club	12 October 1964
5. Balance of work in twelve months		

The contractor was better organized than at Transit camp and progress was fairly good. However, local workmanship was poor and some work had to be pulled down, especially in the JRC. In June it became apparent that some of the completion dates would not be met, mainly due to non-arrival of certain project stores. The programme was then adjusted to speed the work on the three messes at the expense of progress on the JRC. The camp was finally handed over to the incoming units in October and November. The initial contract was fully completed in December 1964 but additional work was already in an advanced planning stage, to be let to contract under the supervision of the MPBW.

EXTENSIONS TO THE CANTONMENT AT LITTLE ADEN

The cantonment was located west of the main Jebel area, on the edge of the sand flats and consisted of three camps: Falaise, Mandalay and Mareth. Some forty Twynham huts existed as temporary accommodation in Falaise having been erected eighteen months earlier by the Aden Independent Troop, RE. The task given to the CRE in February 1963, was to construct the accommodation for the Brigade Field Squadron and the Brigade HQ in Mandalay lines, a total of twenty-three huts. In March the staff requirements changed and an extra 16½ huts were needed and together with some offices and stores, the total rose to 47¾. The CRE was able to take on this now major commitment, as approvals for the re-entrant sites were still awaited. The work was started with a very "scratch" labour force, with some tradesmen from the Aden sites and locally recruited labour, under the supervision of a Clerk of Works. This situation continued until the third Troop of 32 Squadron arrived in July, when a better balanced team could be organized.

The design for the projects was being prepared by consultants for the MPBW but the CRE planning staff was able to make considerable savings in the amount of earthwork needed. One of the sites was on fairly level firm sand but the area for the huts in the Brigade administrative area was scree and about 10,000 cu yds of earthwork was required to be done. This was carried out by Engineers and also included the sites for the permanent construction, in the three complexes, which was let to contract in Phase II of the main MPBW contract. The Brigade HQ complex was adjacent to the main road, on soft sand, with similar conditions to those at Transit camp.

Construction. At the beginning, work was very much on an *ad hoc* basis but progress was made. The huts were constructed in three main complexes, with roads, pathways connecting huts, parking areas and fencing. The priorities for the 47¾ huts were:—

Camp	*No of huts*	*EDC*
1. Mandalay line; Field Squadron lines	12½	July 1963
2. Mandalay and Mareth lines: extra quarters	18¾	September 1964
3. Mandalay lines; Brigade HQ, OFP and Fd Amb.	16½	October 1964

Concrete for the huts in Priority I was mixed at site but as soon as progress allowed, the central batching plant was moved from Normandy to the area near the Brigade HQ and produced the concrete for huts in Priorities 2 and 3.

Photo. 5. The Cantonment, Mareth Lines. A battery of 1 ton air-conditioning units installed in a 128-ft Twynham hut.

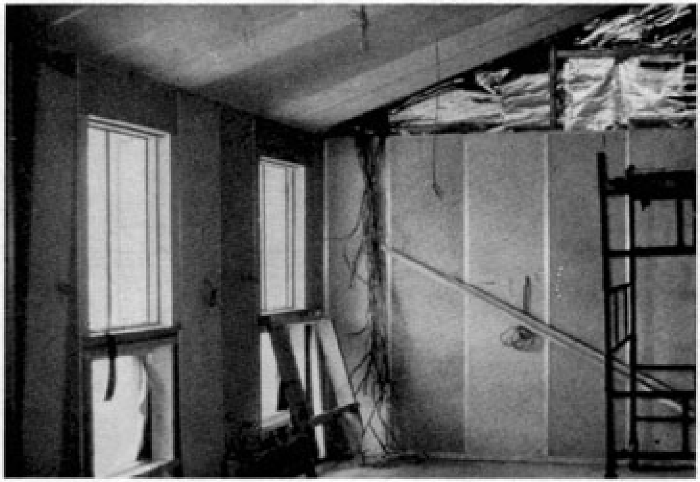


Photo. 6. Mareth Lines. Hut under construction showing wooden frames under windows for 1 ton air-conditioning units, also cabling ready to go into distribution box.

Construction Of Development Camps Aden 1962 to 1964 5 & 6

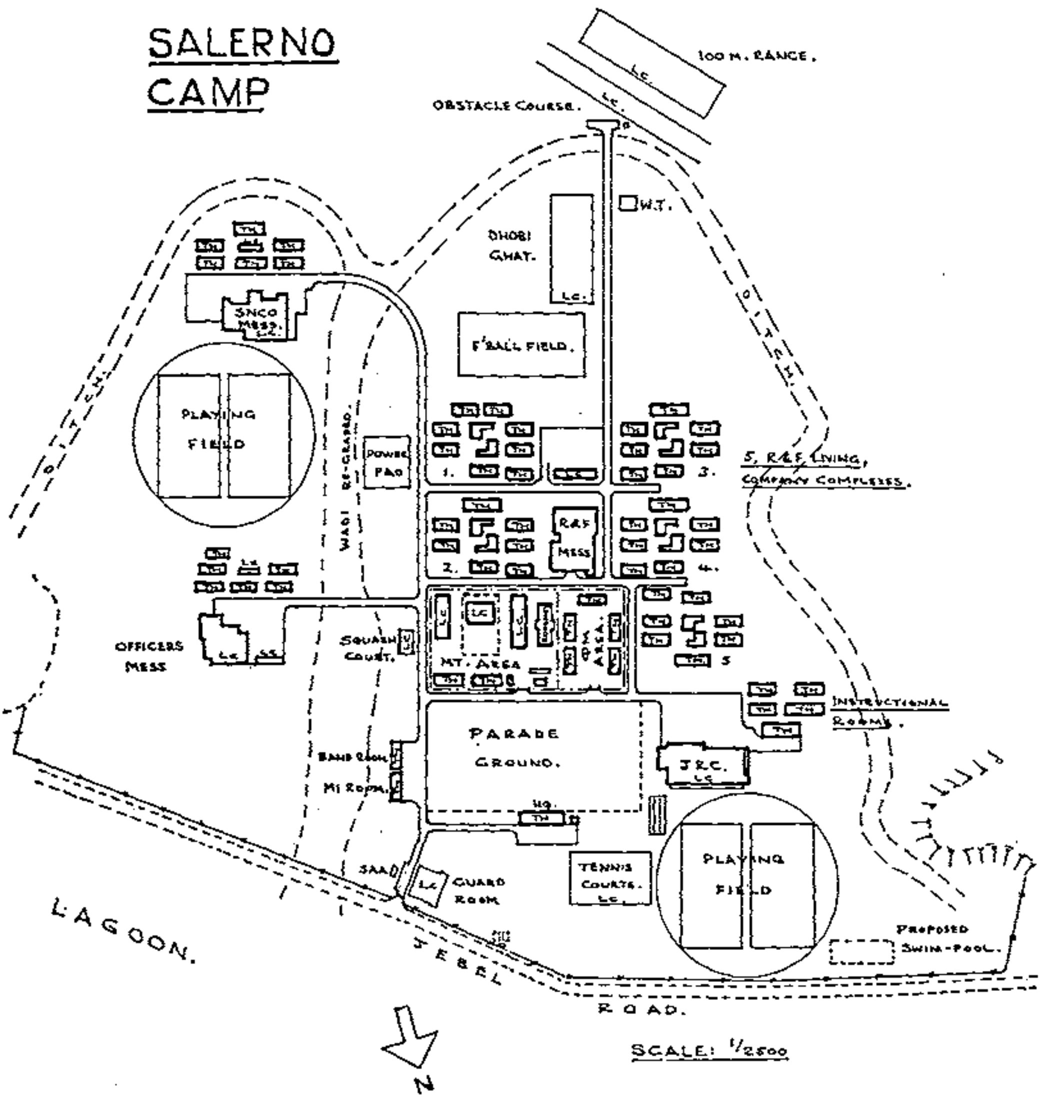

SALERNO CAMP
100 M. RANGE.
OBSTACLE COURSE.
W.T.
DHOBI GHAT.
F'BALL FIELD.
SNCO MESS.
PLAYING FIELD
POWER PAD
WADI RE-GRADED.
DITCH.
5, R.&F. LIVING, COMPANY COMPLEXES.
R&F MESS
OFFICERS MESS
SQUASH COURT.
MT. AREA
QM. AREA.
INSTRUCTIONAL ROOMS.
PARADE GROUND.
BAND ROOM
MI ROOM.
J.R.C.
H.Q.
SAA
GUARD ROOM
TENNIS COURTS.
PLAYING FIELD
PROPOSED SWIM-POOL.
LAGOON.
JEBEL ROAD.
N
SCALE: 1/2500

Figure 2

R.E. CONSTRUCTION • SALERNO •

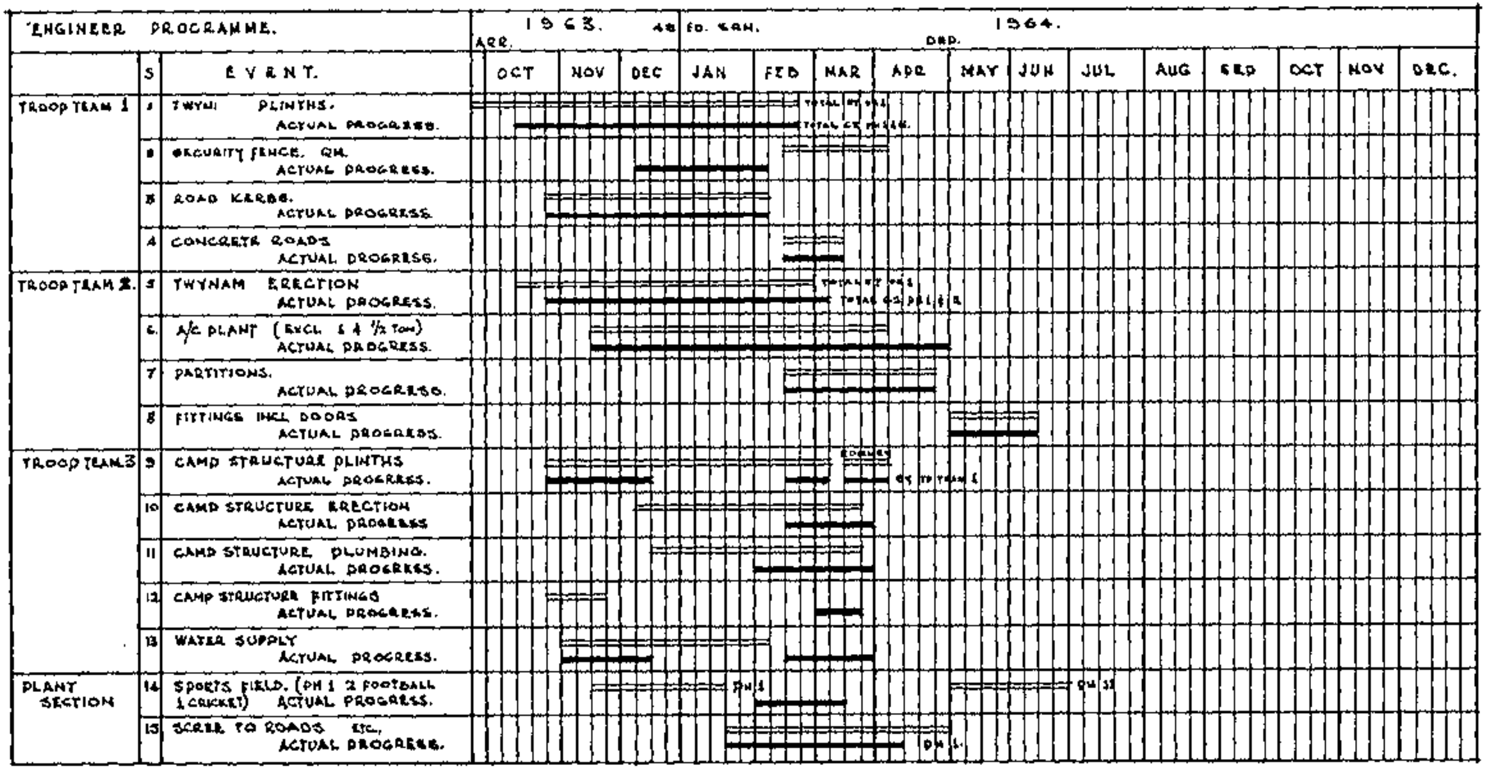


Figure 3

The plant remained at this location until September 1964, when it was finally moved to Anzio. Progress improved when a full troop became available and later, a second troop was also employed to complete the work. The 16½ offices and stores in the Brigade HQ complex were all partitioned and fitted with a number of internal doors and included a Conference Room with raised seating and extra lighting. The contract work in the Ordnance Field Park and the Field Ambulance areas, included a high Marston shed as garage and workshops and vehicle ramps and washdowns. This was finally completed in February 1965 but the Twynham accommodation was taken over by Brigade HQ in October 1964.

Salerno Camp

Salerno camp was located in No 1 Re-entrant at Little Aden. It was specifically designed for a Guards battalion, with additions to the normal synopsis scales; for example, the NCO's Mess and the JRC were larger and partitions had to be built into all living huts to provide a separate room for Lance sergeants. The layout of the camp was arranged with Officers' and NCOs' quarters on the east side of the main camp through road. The five company living complexes, the QM and MT compounds were on the west side, with the main dining hall centrally placed. The division of work was the same as at Normandy. Engineers would construct the huts and other external work and the permanent buildings would be let to contract. Occupation at least to "get you in" stage was required by May 1964.

Planning. In 1963 planning had been based on completing the Engineer work with the contract, in twelve months, to meet the occupation date. However, the embargo in force at the time, was reducing the time available and would increase the Engineer commitment. It would also involve erecting a large number of camp structures and completing other external work, for the "get you in" stage, and it had been hoped this extra work would be avoided. Approval for the Engineer work was received in August but not the contract and time available for the work was reduced to about seven months. The work was now replanned, employing a full squadron, instead of two troops, with supporting labour to complete the task. 12 Field Squadron were to relieve 32 Squadron and an additional squadron was requested and Headquarters 38 Corps Engineer Regiment came out to Aden with 48 Squadron in October 1963, to undertake the task, staying six months. A detailed works programme was sent to the Regiment in England in August so they could study the project. The time available was based on 110 working days and the programme was phased as follows:—

Item	Phase IA EDC April 1964	Phase IB EDC May 1964	Phase II EDC December 1964	Total
Twynham huts	55	7	6	68
Camp structures	33	—	—	33
Security fencing	100%	—	—	100%
Roads and hardstandings	80%	20%	—	100%
Sports pitches	2	1	2	5
Cricket tables	1	—	1	2
Romney sheds, 96 ft long	1	—	—	1
Temporary water supply system ..	100%	—	—	100%
Temporary power supply	100%	—	—	100%

To complete the task in Phase IA and IB in six months, the following progress would have to be maintained:—

1. Complete four huts per week.
2. Complete 200 FR of roads and kerbs per day.
3. Complete two camp structures each week.
4. Lay the temporary water supply as labour became available from other tasks.

Twynham hut construction lent itself to what we termed the conveyor belt system, also used at Normandy and was broken down into five stages:—

1. Excavation of the base.
2. Concreting the base and air-conditioning plinths.
3. Erection of the hut.
4. Air-conditioning.
5. Internal partitions and doors.

The works programme for Salerno is set out in Figure 3 which shows the event, time taken for each event and the troop/team employed on the task.

Site preparatory work. Almost three months was spent on preparing the site. Firstly, there was no water on site and a 4-in victaulic pipeline was laid by 32 Squadron from the supply in the Cantonment to site (a connexion being left for Anzio) and 14,000 FR of pipe was used. It was laid along the beach of the lagoon, clear of the formation for the new Jebel road. On site a 6,400 gallon Braithwaite tank provided the supply for construction and the temporary supply system. Later the pipeline was connected to the 80,000 gallon tank, built under contract and supplied the camp until the new mains supply line was completed in December 1964. The sub-soil on site was scree and provided a good base for construction. In the final plans prepared by the consultants, 80,000 cu yds of earthwork was involved but the CRE planning staff was able to reduce this to about 60,000 cu yds. The CRE was anxious to start the earthworks at an early date but, without approval, the Lands Department were reluctant to give authority. Finally, the Chief Engineer AMWD, obtained permission, with the help of the High Commissioner, for the area to be used for plant training. Work began in June 1963 and was completed in August.

A concrete batch mixing plant was erected, consisting of three gravity hoppers, one for sand and two for aggregate, feeding down into two 14/10 mixers. The hoppers were built in timber and a roadway was ramped up level with the top of the hoppers and kept filled by Michigan from the stock piles at the sides of the ramp. The mixers were fed by hand and discharged into dumpers at the front. The water content was over gauged 2 gallons per mix, to offset the fast evaporation rate and to allow for vibrating. A large working area was constructed with separate troop working areas and the workshop was moved from Normandy, together with the resources compound. A plant park was also set out, in which all the plant was held and maintained centrally. In August, project stores began to arrive and to avoid double handling, huts and air-conditioning units were off loaded at erection sites. Aggregate, 4,500 tons was being delivered by contractor and suitable sand was also being stockpiled.

Construction. The concrete programme required an average of 40/50 cu yds per day. The method of concreting the bases was the same as Normandy, with four sets of shuttering. The huts had double verandahs, the rear overhang supported on a kerb with the concrete verandah in front. The base formwork was divided into six bays, each bay requiring 4 cu yds of concrete and the daily amount was 38 cu yds. A reinforced base 90 × 60 ft, 9 in thick, was also cast for the temporary power pad. It was designed for six 350 KVA generators and a team of Engineers came out from the United Kingdom to assist with the erection and operation of the sets, when installed, under the supervision of the MPBW.

The various teams soon got under way and had no difficulty in completing four huts per week in Phase IA. Progress became so advanced that work continued on Phases IB and II and all the huts were completed ahead of schedule, although some of the internal work remained to be completed. The first frame was erected on 4 November and the last hut in Phase II on 21 March 1964. The majority of the huts were standard, but some 96 ft huts were also built; 120 partitions were built into the living huts, offices and stores and fifty-six internal doors were fitted.

Camp structures. Standard camp structures were modified to suit the designs required, some items were not available and were made up on site. The structures were erected on concrete beds and included four kitchen units, as well as showers, latrines and urinals. Elsan closets were used in the latrines and the urinals drained away into soakaways through the beds. The plumbing was simple as only cold water was laid on. Waste from the kitchens, showers and ablutions passed through the main camp drainage (built under the contract) into a large sump and separator and into the lagoon but this was limited to 3,000 gallons per day.

The contract. The site was handed over to the contractor on 20 January 1964 but little progress was made until the end of February owing to Ramadan. The B and CE contract was for £172,000 and the contract time twelve months, the cost of stores incorporated by Engineers was £200,000. The design of the buildings was similar to those at Normandy with the addition of a guardroom and armoury, sports pavilion, squash court and miniature range. A separate contract was let for the ventilation and air-conditioning to the kitchens and the M and E work. The contract was phased with the Engineer work on the 'get you in' basis as follows:—

Phase IA: public rooms to messes in six months.

Phase IB: kitchens to messes, some MT works, armoury and ablution blocks in eight months.

Phase II: balance of the work in twelve months.

In May the occupation date was put back to October and this gave more time to complete the various phases. Now every effort was made to complete as much of the contract as possible before the arrival of the battalion. Phase IB was completed and co-incided with the arrival of the main party on 14 November. However, this was only achieved by constant detailed supervision by the Garrison Engineer and his staff. The sewage was to be pumped to the farm in the Cantonment along the Jebel road but by January 1965 the scheme had not been approved. The ablutions had been completed but could not be used and this was most frustrating for the battalion.

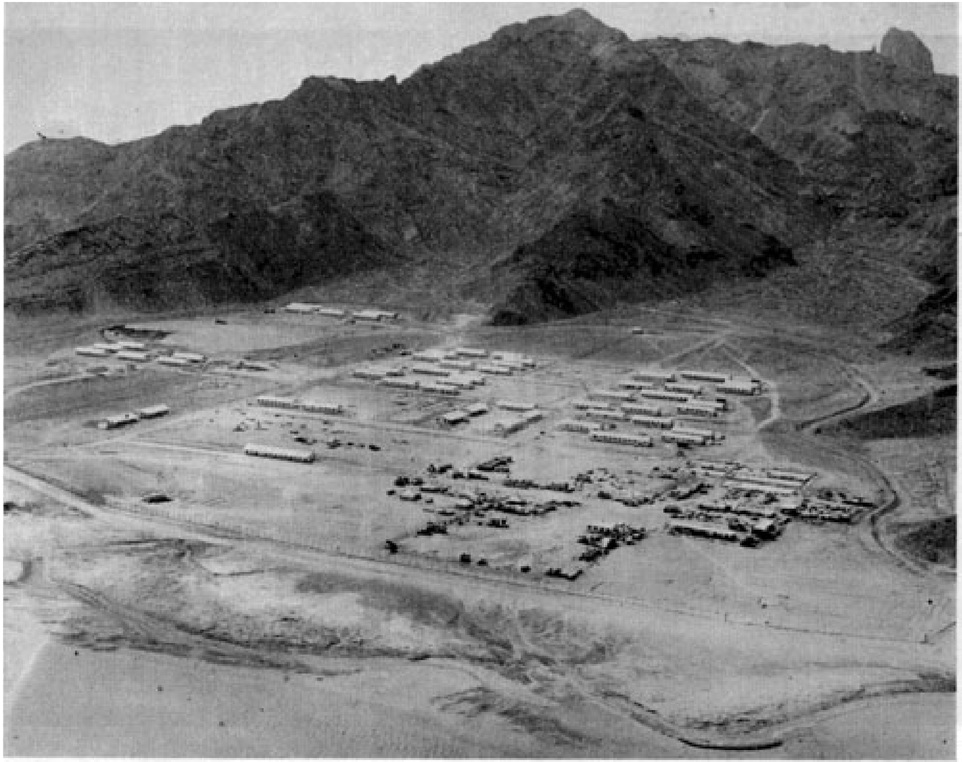


Photo. 7. Salerno Camp. Under construction viewed from the north with Plant Park and Stores area in the right foreground. Company complexes in the centre and Officers and Sergeants quarters on the far left.

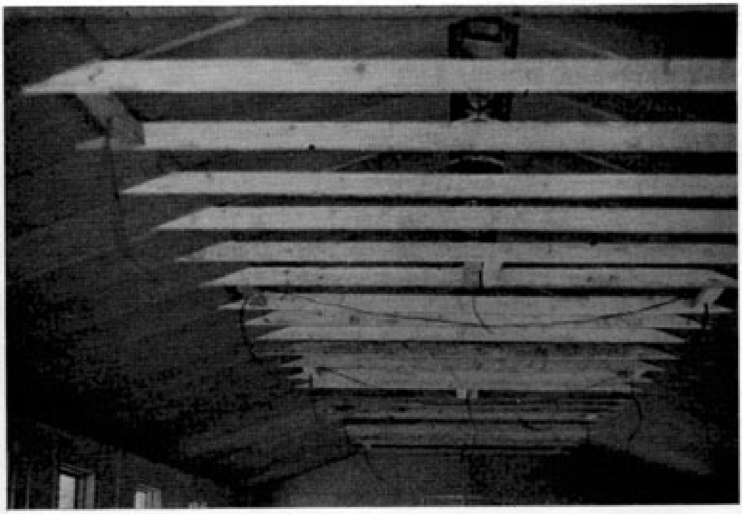


Photo. 8. Salerno Camp. Twynham hut with false ceiling showing purlins and ends of cables from EL wiring harness.

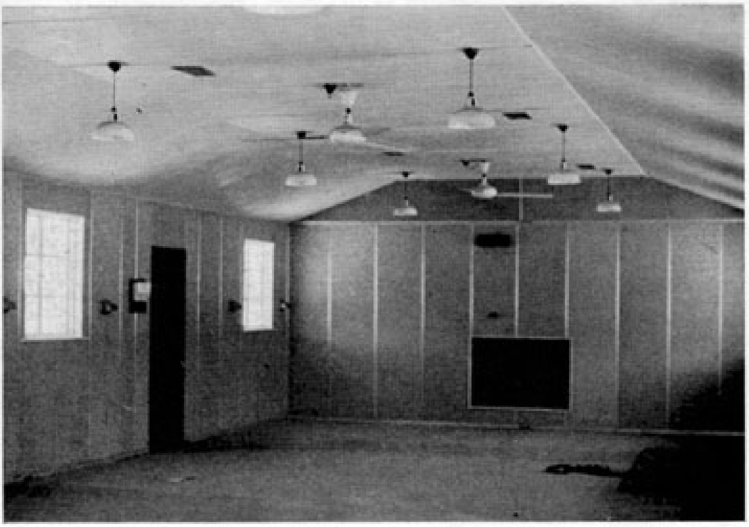


Photo. 9. Salerno Camp. Completed hut with false ceiling showing fans and lamp fittings and air-conditioning grills.

Construction Of Development Camps Aden 1962 to 1964 8 & 9

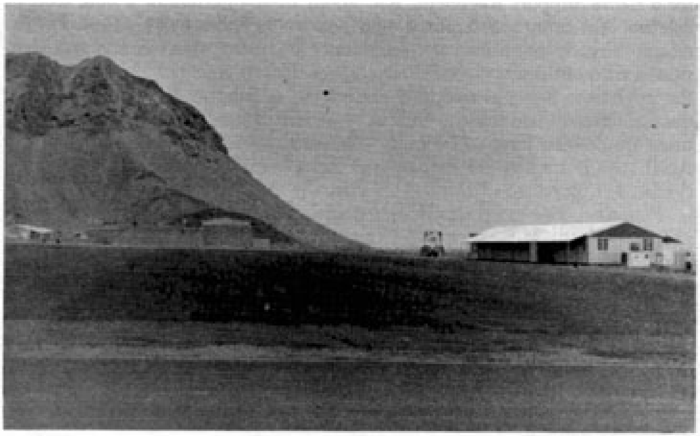


Photo. 10. Salerno Camp, view across the parade ground with Bn. HQ on the right.

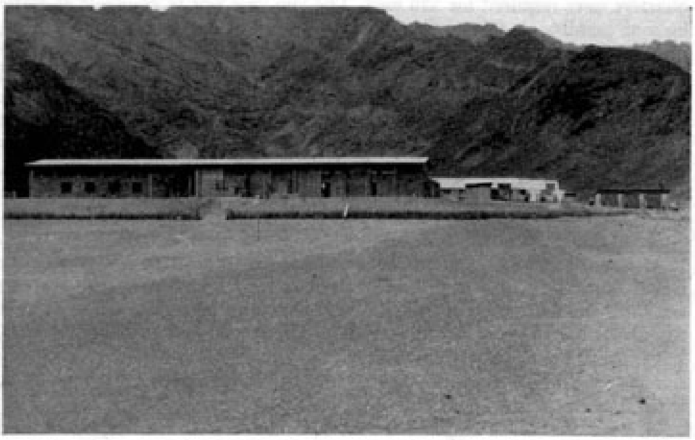


Photo. 11. Salerno Camp. Warrant officers and Sergeants mess under construction, viewed south across the sports field.

Construction Of Development Camps Aden 1962 to 1964 10 & 11

Anzio Camp

Anzio was similar in all respects to Salerno but smaller, the main difference was the addition of a large Gunpark at the top of the camp. It was designed for a Close Support Regiment, RA, about three-quarters of a mile west of Salerno. The camp was required on a "get you in" basis by May 1964. For the reasons already mentioned the programme was being delayed and an extension of six months was given. However, new factors emerged which prevented the work from being as smoothly carried out as Salerno. In May the work in the Cantonment had priority and the reduction of time meant that camp structures would also have to be built. The earthworks had been completed in April 1964 but when the Radfan operations began, 12 Squadron were much depleted to assist up country. This virtually stopped work at site.

Planning. The camp was designed with four separate battery living complexes, with the MT and gun parks towards the head of the re-entrant and the Officers' and NCO's quarters either side of the parade ground. The CRE designed the layout and his planning staff assisted the consultants in completing the design. The Engineer work was phased as follows:—

Item	Phase IA	Phase IB	Phase II	Total
Twynham huts	43	8	4	55
Camp structures	25	—	—	25
Security fencing	100%	—	—	100%
Roads and hardstandings	75%	25%	—	100%
Sports pitches	0	2	2	4
Temporary water supply system ..	100%	—	—	100%

In June 1964 the Squadron task was to complete twenty-two huts, camp structures, water supply and 2,000 FR of roads by 1 October. In July it was decided that the camp should first be occupied by the newly formed MELF Park and 24 Squadron, due to take over from 12 Squadron in October and quarters were required for 350 men. The aim now was to complete as many huts as possible and forty-four were ready for the squadrons in October, including water supply and electricity, supplied by mobile generators. By January 1965 a total of fifty huts had been completed, under difficulties and many frustrations. The contract was let on 14 December 1964. The work was phased in the same way as at Salerno. The B and CE was valued at £196,000 and the design of the buildings was similar to Salerno, for completion in twelve months. The contract was finally completed in May 1966.

Jebel Road

The Jebel road provided access from the Cantonment to Anzio and Salerno. It was planned to connect with the main Aden road near the bridge over the lagoon but this was dropped. The work involved improving the existing track, on the north side of the Jebel Am Muzalkan, alongside the lagoon. It was about two miles in length and the existing surface was scree and sand, rolled hard by the passage of traffic over the years. In places it followed closely the bottom of the steep rock outcrops and the width varied from 30 to 50 ft, with curves as sharp as 60 ft radius.

In 1963 the Chief Engineer AMWD, asked the CRE to report on and produce a design for the road. The road was designed for speeds up to 20 mph with minimum radius curves of 150 ft. The standard carriageway was

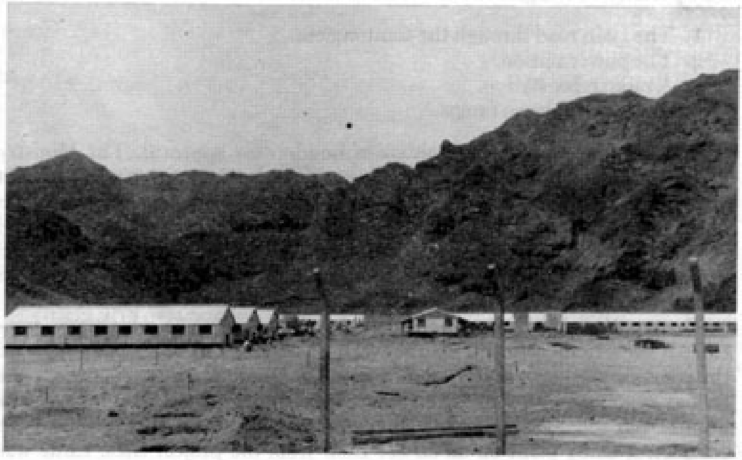


Photo. 12. View of Anzio under construction from the north with Officers living huts on the left.

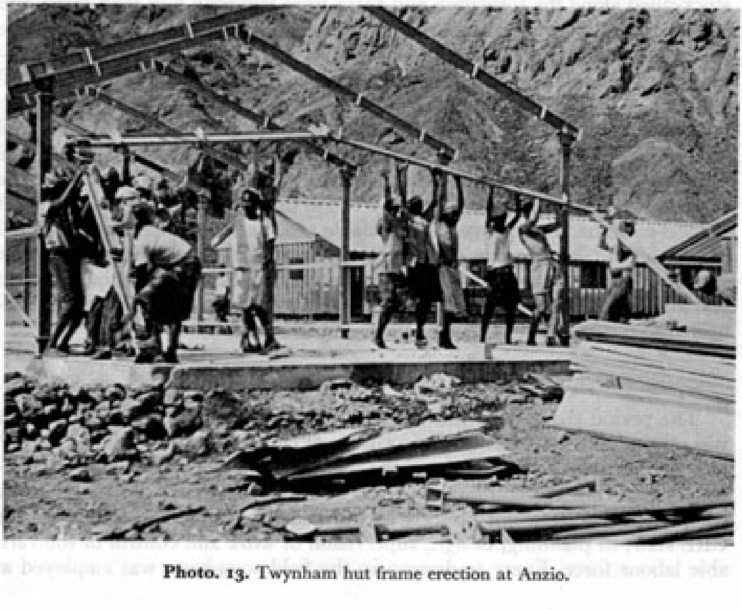


Photo. 13. Twynham hut frame erection at Anzio.

Construction Of Development Camps Aden 1962 to 1964 12 & 13

22 ft with flush kerbs, with dual 16 ft carriageways on curves, where the sight line of 300 ft could not be achieved and capable of taking Centurians on transporters. The alignment had to tie in with:—

1. The main road through the Cantonment.
2. The power station.
3. A radio relay station.
4. Anzio and Salerno camps.

The design had to be submitted to London for approval. The Ministry pressed for a road with 450 ft radius transitioned curves; it was pointed out that this would double the amount of earthwork and increase the construction time. Finally, it was agreed that the 20 mph Criswell transition curve would be used and the drawings were amended. The original survey was carried out by 19 Topographical Survey Squadron in April and the final alignment was set out by 13 Field Survey Squadron in July 1964.

Construction. It was mainly a task for Engineer plant which was non-costed; the overall estimate for the work was about £40,000 which included the concrete for kerbs and local labour. The intention was to commence the task in September 1963 but the various delays prevented a start being made until March 1964. By the end of July, 60 per cent of the earthwork had been completed, using plant on an *ad hoc* basis from the project sites. Little was done during August and September and on the arrival of 24 Squadron in October a new programme was drawn up to complete the formation and commence laying the kerbs ready for surfacing by contractor. This involved tipping a further 18,000 cu yds of fill and laying 8,000 FR of kerbs. In October, some plant had to be sent up-country to assist with urgent agricultural relief work but, despite this, some progress was made. Materials had already been stock-piled along the formation and kerbs were laid with 8-in road forms and a daily target of 500 FR was set. By the end of January 75 per cent of the kerbs had been laid and the surface was being prepared for surfacing. Progress was not smooth and the road was not finally completed until April 1965.

The Services. The main services for the two camps; water, electricity and signal cables, were laid in the verge of the road and when approved, the sewage would be laid in the berm on the lagoon side. The trench for the services was 4,300 FR, 4 ft wide and 3 ft 3 in deep and the excavation was let to local contract. This proved a formidable task, as 80 per cent was excavated in rock and took some four months. The water main was connected to a new supply in the Cantonment and consisted of 9-in cement asbestos pipe to Anzio and 7-in from Anzio to Salerno. The three services were completed and connected to the camps in December 1964.

Conclusions

The period covered by this article is just over two years and the author was serving as the DCRE works in charge of construction from January 1963 to 1965. During this period the major part of the deployment work was completed and only the contract at Anzio and the Jebel road remained to be completed. The series of projects had provided valuable experience for the CRE staff; in planning, design, supervision of work and control of the variable labour force. Every tradesman in the field squadrons was employed at

Photo. 14. Jebel road under construction, with huts at Anzio in the background.

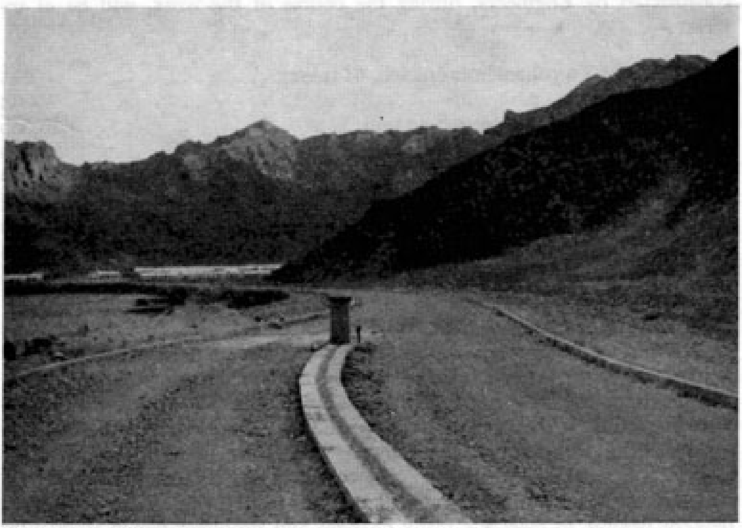


Photo. 15. Same view, after concreting the centre up stand kerb on a dual carriage-way curve.

Construction Of Development Camps Aden 1962 to 1964 14 & 15

Photo. 16. Jebel road. Method of concreting flush kerbs with shuttering on one side only, set 2½ in above natural soil level. This method was used on the construction of all roads.

his trade and many earned up-grading. A brief summary of the main items constructed by Engineers, during the course of the work, will be of interest:—

Number of Twynham huts erected, 64 ft long	225
Romney sheds	3
Quantity of concrete poured, in tons	20,000
Concrete road kerbs cast, in FR	50,000
Security fencing, 10 ft high, FR	21,000
Number of all types of air-conditioning units fitted	412
Number of fan hooks made in Workshops	1,200
Timber used in false ceilings, FR	88,000
Hardstandings, in yards super	55,000

Plant casualties were heavy. Apart from the fact that initially, operators were somewhat inexperienced, the climate was severe on all equipment. This was aggravated by the fact that there was no covered storage in the Ordnance park in Aden and some items had been held in store for a number of years. Spares backing in the main was inadequate and there were cases of equipment awaiting spares for up to eight months.

It was a full and interesting programme and everyone worked with a will, the climate was unpleasant and at times most trying. Planning had to be kept flexible to meet the many changes and problems which frequently arose.

APPENDIX "A"

Commander Royal Engineers, Deployment Camps, Aden

(i) Personnel

Commander Royal Engineers (Lieut-Colonel)	1
Deputy Commander, Royal Engineers (Major)	2
Electrical and Mechanical Officer (Major)	1
Quantity Surveyor (Major)	1
Stores Officer (Major)	1
Administrative Officer (Captain)	1
Planning Officer (Captain)	1
Garrison Engineers	3
Total officers	11
Clerks of Works:—	
Constructional (WOs or Staff/Sgts, including one WO class I)	8
Electrical (WOs or Staff/Sgts, including one WO Class I)	4
Mechanical (WOs or Staff/Sgts, including one WO class I)	4
Chief Clerk (WO class II)	1
Storeman (Tech, WO class II)	1
Storeman (Tech, Sergeants)	3
Draughtsman (Civil and Structural, Staff/Sgt or Sgt)	1
Total, WOs, Staff/Sgts or Sgts	22
Draughtsmen:—	
Civil and Structural (Corporal)	2
Mechanical (Corporal)	1
Clerks, RE (including two Lance/Corporals)	3
Storeman Tech RE	1
Surveyors Engineers	2
Total, rank and file	9
Total, other ranks	31
Total, all ranks	42
Civilians (locally employed):—	
Batmen	5
Gangers	3
Labourers	30
Storemen	6
Carpenters	6
Drivers (including one Foreman)	10
Total, civilians (locally employed)	60

(ii) Transport

Trucks, cargo, $\frac{1}{4}$ ton 4×4	9

APPENDIX "B"

List of Engineer Plant and "B" and "C" Vehicles

Engineer Plant

Dumpers 4½ cu yd	6
Dumpers ½ cu yd	10
Rollers, road, 6/8 and 8/10 ton	3
Concrete mixers, 14/10	10
Compressors, 315 cfm	2
Compressors, 105 Pescara	2
Generators, 27.5 KVA	3
Generators, 10 KVA	1
Machines wood working universal	2
Rollers, vibrating	2
Vibrators, screed	8
Total	49

"B" Vehicles

Tippers, 3 ton	10
Tippers, 10 ton	5
Bowsers, sullage, 5 ton	1
Trailers:	
water, 1 ton, 200 gallons	4
circular saw	2
welding	2
servicing, 2 ton	1
20 ton low-loader	1
Scammell	1
Trucks, 10 ton machinery	1
Total	28

"C" Vehicles

Tractors, crawler, size I, DH8	3
Tractors, crawler, size IV, Drott	3
Tractors, wheeled, light	3
Tractors, wheeled, medium	2
Scrapers, 8 cu yd	2
Graders, 12 ft	3
Excavators, tracked, 19 RB	2
Excavators, wheeled, BK 50	1
Cranes, Jones, KL 66	2
Total	21

Ahmed's Parable

By Major A. M. Pyne, RE
(recently OC 2 Armoured Engineer Squadron)

"Ah! Then yours wasn't a really good school," said the Mock Turtle. "Now at *ours* they had at the end of the bill, 'French, music, and washing—extra'."

(Lewis Carroll)

An Unfinished Parable

There was once a military family with many children. As the children grew up, some of them left the security of their parents' home, settling down independently. One of these was known as Tancore, another Korsigs. I forget the names of the others, but I recall that Korsigs was especially popular with his parents, for he used to return to them biennially for a celebration; and in the intervening years he would offer his parents the hospitality of his own household.

Other children of the family remained under their parents' roof, moving only into separate wings of the big house. Their names were unusual also. One recalls Cervay particularly, a big chap, jealous of his independence and yet still very much part of the family.

One of the youngest children was different; not a black sheep by any means, but nevertheless he stood apart in a way which is difficult to analyse. Christened Ersalt, he did not take to this soubriquet particularly and he rather pointedly changed it, when he was confirmed, to Ahmed.

As a youngster, Ahmed had been presented by his parents with some interestingly different toys of a mechanical nature. He enjoyed these enormously and soon learnt to put them to good use; but oddly enough his brothers and sisters took only a passing interest in them. Perhaps they found them too complex or thought them too fragile to be used by anyone other than the owner. Ahmed's parents, preoccupied with those important affairs which tend to engross adults, watched his activities with mild approval but certainly not with overwhelming enthusiasm.

A little disappointed by the apparent coolness of his family, Ahmed was consoled by the interest shown by his friends, who were always anxious to invite him to bring his playthings to their homes. Together they discovered many fascinating uses for his treasures, and on more than one occasion the delighted Ahmed was assured, as he left, that his toys were better than anyone else's in his family.

Ahmed is now a young adult and his toys have been replaced by more sophisticated ones—which, grandly, he calls "equipment". Speaking to me today, he explained that he has always been puzzled by the contrast between the outlook of his friends and that of his own flesh and blood. "If only," he said to me in a sudden burst of confidence, "my family could be made to understand just how useful and entertaining my equipment is, why they would get some of their own—and even perhaps throw away some of the stuff they amuse themselves with at present."

Introduction

After the successful assault on the so-called West Wall in 1944, the retention of armoured engineers (then known, of course, as assault engineers) in the order of battle indicated that engineer tanks had come to stay—not for the special task of assaulting "fortresses", but for general use on the modern battlefield. Indeed the number of armoured engineer equipments in the British Army has fairly recently been increased.

The equipment is concentrated in armoured engineer squadrons, which means that these squadrons, whether they like it or not, are specialist units. Yet a study of their role in modern war may suggest that their task is indistinguishable from that of divisional engineers; in which case it seems that there must be a degree of duplication. Have we perhaps two sets of equipment to perform the same task? Though it is not necessarily wrong to hold two sets, it can only be excused if each is the clear superior of the other in its own special sphere. It is therefore essential for all engineer officers to know the capabilities and limitations of *both* sets of equipment; for if they do not, how can they possibly judge which set is best suited to the demands of a particular situation?

Nearly a decade ago there appeared in the *RE Journal* an article entitled "Armoured Engineers" by the then Lieut-Colonel R. L. France, MC.[1] Re-reading this today, one is struck by the fact that the author did not consider it necessary either to describe armoured engineer equipment or to mention, in any detail, its capabilities. No doubt he assumed that his readers knew all about such straightforward matters. If he was right ten years ago, is he right today? Officers now serving in armoured engineer squadrons are likely to be reasonably well versed in the equipment of the combat engineer, for most of them have spent some part of their service in field squadrons; but the very scarcity of armoured engineer units ensures that the converse cannot be true.

It is not essential, of course, to have served in a unit in order to understand its functions, and if the Sapper officer's education were sufficiently all-embracing there would be no serious problem. Reverting for a moment to the instruction given to the Mock Turtle, one may perhaps equate the "French and music"—relatively common subjects—to the RE officer's education in combat engineering, engineer plant, airfield construction and the like. But it will be recalled that the Mock Turtle's school intelligently included, albeit as an extra, a third subject—"washing". Herein lies the problem, for "washing"—or armoured engineering—receives scant attention at the RSME.

It appears, then, that the average engineer officer, through no fault of his, is ill-informed about armoured engineer equipment, and being so, is unfit to judge when its use would be appropriate.

Let us briefly examine the role of armoured engineers; and then look at their equipment in some detail to see whether it may not be more suitable, in many instances, than the tools normally available to the combat engineer.

Roles

The role of armoured engineers has been officially expressed as follows: "To maintain the mobility of armoured formations in battle, and to deny

[1] Published in the September 1957 issue.

mobility to the enemy". One could well quibble with this wording today, probably substituting the phrase "all arms battlegroups" for "armoured formations", but the message is plain enough.

Not so very long ago this wording would have implied a minor but distinct variation between the roles of armoured engineers and most field squadrons; but today in Europe all arms are armoured, and certainly all formations include a very high proportion of armour. Infantry and Sappers travel in FV 432s, the RAC in tanks or Saladins, much of the artillery in Abbots. The conclusion is irresistible: the roles of armoured engineers and combat engineers in Europe are identical. Why then do we not regard armoured engineer equipment as being part of the combat engineer's armoury—as clubs in the same bag as the heavy ferry, the Class 30 trackway and engineer plant? The answer has always been given that these are special clubs, too difficult for weekend golfers to use and requiring the skilled attention of professionals.

This rejoinder used to have some validity when armoured engineer equipments were based on the Churchill chassis, RAC tanks on the Centurion and combat engineers on 3-tonners. Today in Europe field squadrons are mounted in FV 432s and the Centurion is common to RAC, field regiment OPs and armoured engineers. The advent of the Chieftain does not make too significant a difference since it is a very similar tank, and we shall never again make the mistake—one hopes—of allowing the design of armoured engineer equipment to lag far behind the main battle tank.

In handling their FV 432s, field squadrons in Europe are learning—or have already learnt—to solve the problems of crewing, replenishment, maintenance and repair of armoured vehicles in the field—problems which used to be more or less peculiar, as far as Sappers were concerned, to armoured engineer units. In addition to running these vehicles, field squadrons manage to operate wheeled engineer plant, to run a large radio net and to undertake a host of varied combat engineering tasks. Is it too much to ask them to exchange some of their FV 432s for tanks? The field squadron commander's immediate reaction would probably be "Certainly. Life is difficult enough already." But suppose that these tanks enabled the field squadrons to perform some of their combat engineering tasks much more quickly, more efficiently and without the need for many stores vehicles? Might not the bill then be worth paying? Let us see.

The Bridgelayer

A company/squadron combat team, moving across country, is faced, let it be supposed, by a stream somewhere between 20 and 45 ft wide. All the bridges have been blown, and the stream has vertical banks. The Commander turns to his Sapper, a field troop commander, for assistance.

Just what can this engineer officer do? Perhaps he will put down some culverting, and then doze a crossing over the top. But even supposing that he is carrying pre-assembled culverting and has a dozer well forward; that spoil is conveniently available and that the tactical situation will permit the dozer operator to start work at once, the job will still take a long time. Or will the troop commander choose to build a Class 60 bridge, perhaps under fire? Never mind construction planning times. How long will it be before the bridging equipment and the working party are there at the site ready to begin work? Nobody will deny that the field troop commander can get his

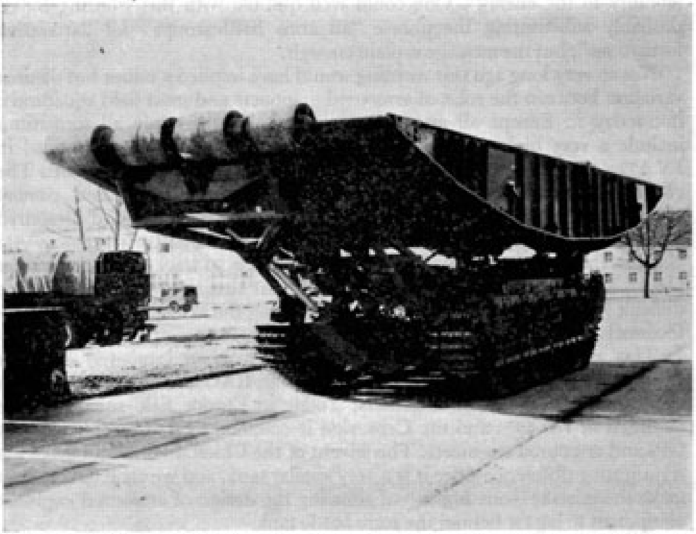


Photo. 1. *The Centurion Bridgelayer.* Note the centre-decking pieces which are bolted to the bazooka plates at the side of the tank.

combat team across the obstacle, but at what cost in time, effort, loss of momentum and perhaps in casualties?

The Centurion Bridgelayer (Photo 1) may provide a solution to the problem. The bridge is 52 ft long, and is Class 80. It can be laid in under five minutes and is usable immediately by tanks and FV 432s. Wheeled vehicles can also cross at once, though it is preferable to position the centre-decking first, a five-minute task. The bridgelayer has two radio sets—a C42 and a B47—and it provides for its crew of three—commander, driver and radio operator—the advantages of *tank* armour, which is more of a protection to them than the relatively thin-skinned FV 432. Moreover the bridge can be positioned with the crew still inside the vehicle. The crew members are trained in combat engineering and they can carry a limited quantity of mine clearance gear, enabling them to play their part, if necessary, in the clearance of nuisance mines. The bridge is fitted with luminaries for use at night, though it is normal to reinforce these with mine-marking lamps. One must not overlook the tremendous advantages of a portable bridge equipped with radio. The engineer officer, having made his reconnaissance, can remain on site and "talk" his bridge to him—without giving formal orders, without the need for marshalling or pre-assembly areas, without stores vehicles, usually without guides, above all without wasting a moment. And the "construction time" is of the order of three minutes!

Are there then no limitations to this equipment? Yes indeed there are. First of all, the bridgelayer is a distinctive vehicle, easily recognizable from air and ground, and tending to draw fire; and its shape makes it difficult to hide. Secondly, although it can bridge gaps up to about 45 ft in width, there are certain sites at which it cannot be used at all. If there is more than 8 ft difference in the height of the two banks; if the cross-slope at the launching point is greater than 1 in 10; or if the overhead clearance is restricted, perhaps by power cables, to less than 54 ft—then one must find an alternative site somewhere else, or change the prevailing conditions by dozing.

Thirdly, the bridgelayer is a brute to move over long distances because the bridge must normally be removed and split into four pieces—each of which requires a 10-tonner for carriage; a transporter is required for the base tank, and a crane is virtually essential at both ends of the move to load and unload the four bridge sections. Lastly, the bridgelayer is a one-purpose vehicle which is of no value once its bridge has been laid, until either the tactical situation allows it to recover its bridge or a replacement is supplied.

Contradicting slightly the last limitation, it is possible to use the bridge when it is mounted on the tank as a container for such things as mines, but it is certainly not a convenient "mine truck" and one should not use it as such except in an emergency.

The Centurion Bridgelayer is of course issued to RAC as well as RE, on a scale of one per armoured regiment. Some regiments are anxious to pass their bridgelayer to engineer command at every possible opportunity, whereas others jealously guard it under their own wing; but the latter are somewhat hamstrung by the fact that they cannot furnish any gap crossing capability to more than a single axis of movement.

It is left to the reader to decide for himself whether the advantages of the bridgelayer outweigh its drawbacks. But if speed is to be the criterion, whether in maintaining the momentum of an advance or re-opening a blocked withdrawal route in an emergency, the bridgelayer surely deserves a place in the combat engineer's armoury of equipment?

The Ark

Let us now give our field troop commander—or for that matter his Squadron Commander, CO or CRE—a slightly more tricky problem. This time he is faced with a river 70 ft wide or, worse still, a canal whose water gap is perhaps only 65 ft but whose flood banks bring the total width of the obstacle to over 100 ft. (And here it is worth noting that the vast majority of water gaps in Europe are less than 75 ft wide.) Let it be assumed that the exit bank at this obstacle is too steep for a swimming APC to negotiate—a common enough situation—and the water too deep for a tank to ford.

The problem once again is not simply to get the battlegroup or combat team across, but to do so without losing any more momentum than necessary. Digging deep into the combat engineer's toybox one finds—what? Medium girder bridge? Even if the 100 ft version will span the gap, the bridging vehicles must be marshalled, brought forward and delivered to the site; and construction will then take at least a further hour. If the gap is over 100 ft, the timings will be considerably increased. What else then? HFB perhaps? A heavy ferry used as a bridge? A dry HGB, or even EWBB? These dry bridges will have to be of pretty heavy construction to be Class 60 over an overall span of perhaps 120 ft. Or would one prefer to run the gamut of hauling each FV 432 out of the water on the far bank and inviting the tanks to fit schnorkelling kit (which they will not have with them)? Either way—and a bridge of some sort will be needed for wheels *sometime*—the delay will be considerable and momentum will be lost.

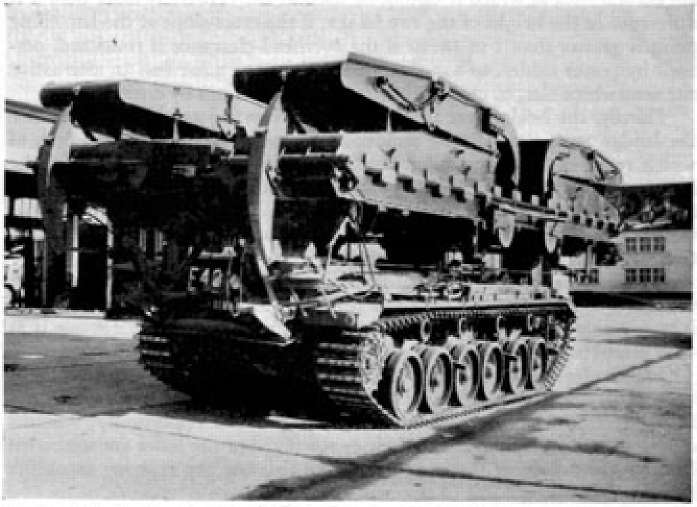


Photo. 2. *The Centurion Ark* (rear view). Note the rear stabilizer (just below the callsign board) which, when released to the ground, moves up and down on a ratchet to reduce rocking as vehicles cross the bridge.

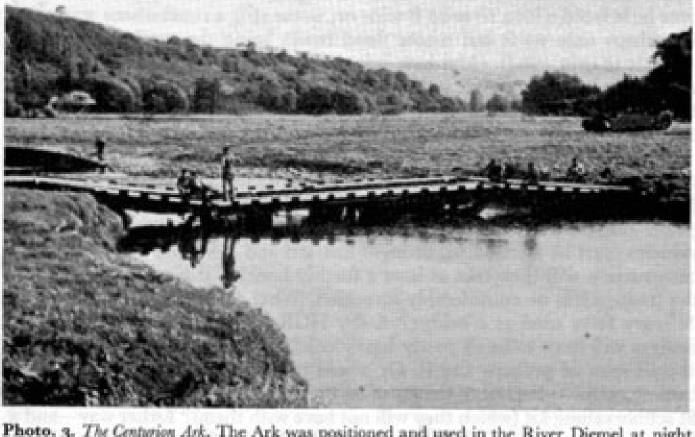


Photo. 3. *The Centurion Ark.* The Ark was positioned and used in the River Diemel at night at this site, where the clear span was 65 ft and the average depth 6 ft 6 in (including 9 in of mud). The photograph was taken the following morning.

Ahmed's Parable 2 & 3

The Centurion Ark (Photos 2 and 3) may provide a very much simpler solution. The Ark has the same crew of three men as the bridgelayer, the same excellent 'mechanical mobility' thanks to its two radio sets, and basically the same one-purpose role; but the Ark actually enters the obstacle, the hull acting as a central pier for the bridge which is formed when the ramps are launched on to the banks. The Ark can be waterproofed to operate in up to 9 ft of water, though there are certain practical limitations to be mentioned later. Once the vehicle begins its entry into the water, a bridge fit for tanks should be ready for use within 6 min, though it will involve another 15 min before the crossing can be made fit for other types of vehicles by the addition of centre-decking.

The Ark ramps when horizontal span 81 ft, and the resulting bridge is Class 80. One tends to regard the gap crossing capability of this equipment as up to 75 ft, which is generally true; but in certain circumstances more can be achieved than one might suppose for reasons which follow.

Digressing for a moment at this point, it is generally known that the next generation bridgelayer will have a considerably longer bridge than the present 52 ft version. At first sight it might appear that a bridgelayer with an effective span of 75 ft or more would put the Ark out of business, for it seems plain enough that it is easier to lay a dry bridge *across*, than to put a tank *into* a river. Curiously enough this is not entirely true. The priceless advantage of the Ark is that the bankseats do not matter very much. The ramps are hinged in three places and they tend to "contour", or take up the shape of the bank, while much of the load is taken by the hull acting as a pier.

In the autumn of 1966 a single Ark was placed in a river at a point where the water was 68 ft wide, and the gap between the tops of the floodbanks was *114 ft*. The Ark ramp tips landed towards the bottom of each bank and dug themselves in. Crossing vehicles had a steep run down the home bank, then a horizontal ride across the Ark and finally a steep climb up the enemy bank. But steep though the exit bank was, crossing vehicles could get a good run at it along the main deck of the Ark. A bridgelayer with an effective span of even 100 ft would have been helpless here without a major dozing effort first to reduce the gap to be bridged. So let us not make the serious mistake of assuming that the next bridgelayer can entirely supersede the Ark.

Arks can be used in tandem for particularly wide gaps, thus increasing the effective span available from 75 ft to about 130 ft; but positioning them is tricky and there are some possibilities of long delays unless events proceed entirely according to plan. They can also be used for wall climbing—up to 19 ft above the Ark's tracks. In the case quoted in the last paragraph, for example, if tandem Arks had been used, the Ark on the enemy side of the river could have positioned its ramps to reach up to the top of the exit bank; which would have been of real value had that bank been even steeper than it was.

What then are the Ark's disadvantages? Once again it is a distinctive vehicle, though rather less so than the bridgelayer. It is unwise to hide it in thick woods because some of the launching equipment can be damaged by impact with trees. Camouflage is therefore a problem, probably best solved (making use of the box-shape of the vehicle) by cloaking it in hessian painted to look like a building or a haystack. Launching ropes break occasionally, and although emergency launch facilities are available, the need to use them will prolong the operation at a somewhat critical moment.

Another drawback is that the Ark's centre-decking cannot be carried on the tank, which means that a separate vehicle must accompany it. Centre-decking is really necessary for all types of crossing vehicle except tanks, though FV 432s can cross without it if the drivers have had prior experience and conditions are good.

The fact that the Ark can be waterproofed up to deck height, 9 ft, does not mean a great deal in practice because the angle of entry is all-important. Whereas the vehicle could motor slowly out on a gently shelving beach to a depth of 9 ft, a very sharp angle of entry into a mere 6½ ft of water might flood the engine compartment. Water depth and entry angle taken together can therefore render the Ark unusable at certain sites.

Like the bridgelayer, the Ark is a nuisance to move over long distances, as the ramps must be removed by crane and placed on 10-tonners (two are required to carry the ramps for one Ark); a transporter is required for the base tank; and a crane is required again at the other end for reassembly.

Lastly, if the Ark is quickly into action it is certainly not quick to "re-load". One should allow a good four hours to convert it from a bridge back into the shape in which it could perform again.

Once again it is left to the reader to determine whether or not this is an equipment which would aid the combat engineer in his task of maintaining mobility on the battlefield. It happens to be Ahmed's very favourite toy, though one should not be unduly influenced by this fact.

The AVRE

If the bridgelayer and Ark are one-purpose equipments, the Centurion AVRE (Photo 4) is certainly not, and for this reason a different approach is appropriate in assessing its value. The capabilities of the vehicle will be described in turn outside the context of any particular situation.

General. The Centurion AVRE has a crew of five (commander, driver, radio operator, gunner and co-driver), all of whom should be trained as combat engineers. They have, of course, the protection afforded by tank armour, and some of them have even better "mechanical mobility" than the bridgelayer and Ark, for one AVRE in each troop has a second C42 in addition to the B47. AVREs carry mine clearance equipment, including a detector, and demolition equipment, including cable and an exploder.

As a dozer. The first important role of the AVRE is as a dozer. The blade, 13 ft 2 in wide, is fixed, in that it cannot be angled or tilted, but the output is better than that of a Size II dozer. It is not the precision instrument which an ordinary dozer can be in skilled hands because the operator has limited vision and somewhat crude blade control; but it is effective, and the use of high reverse gear enables the operator to move a good deal of earth or rubble in quick time. Two AVREs working together, one furnishing the spoil and the other pushing it to the required position, can make a most efficient team.

The dozing capability of the AVRE serves several purposes, including the construction of causeways in order to reduce a gap to measurements within the capacity of bridgelayer or Ark; improving approaches and exits to all types of crossing; dozing over fascines or Armco culverting; and digging in tanks and other vehicles. (A tank can be dug into a hull-down position by an AVRE in as little as 11 min by a good operator.) Would an armoured dozer of this type be of value to a field squadron?

Photo. 4. *The Centurion AVRE.* The demolition gun, fascine cradle (just below the gun) and the dozer blade are clearly seen in this picture.

As a demolition tool. The second role of the AVRE is as a demolition tool. The 165 mm gun is specifically designed as a demolition weapon, and the make-up of each round of ammunition is such that a total of 31 lb of high explosive is delivered at the target. Allowing for the disadvantages of remote charge placement, this may be equated to the effect of about 20 lb of plastic explosive placed by hand and tamped. The ammunition is undoubtedly effective against most types of bridge, including steel girders, but ammunition expenditure is likely to be relatively high.

If the target is a pier or abutment, it can theoretically be engaged from a range of well over 1,000 yds, but it will not be often that it can be seen clearly at this range and one might quote a figure of 800 yds as a normal maximum. If the target is a reinforced concrete slab or T-beam, it will be necessary for the AVRE to be very much closer. The first hit will blow away part of the outside of the slab, and it is then necessary for the second shot to pass through the area of damage of the first in order to continue the "crumbling away" process. The same principle applies, of course, to subsequent shots, and one would, ideally, like to station the AVRE about 300 yds from the bridge to achieve this without undue wastage of ammunition. It is not possible to be specific without quoting dimensions, but an AVRE gunner would be well pleased if he could destroy an RC span on a 24 ft wide road without firing more than twelve rounds—a process which might take him six to ten minutes. A pier or abutment could involve at least twice this ammunition expenditure.

The chief advantage of the gun is probably that it is an "opportunity weapon" which can be employed for bridge demolition at the last moment, either because a conventional demolition has failed; or to complete a job which has been only partially successful; or because a shortage of men, transport or explosive has prevented a field squadron from undertaking the task by normal means. Less important roles for the gun are the destruction of buildings, roadblocks and bunkers, and, *in extremis*, as an anti-tank weapon; but, though the ammunition is most effective against armour, let no one deceive himself into thinking that an AVRE could possibly win a fire fight with a gun tank! Quite apart from questions of range, the AVRE's rate of fire is far too low. The gun has been fired at earth banks—such as river banks—in the hope that they would break up to make it easier for vehicles to climb them; but, despite claims made for the original petard, this has not proved very successful.

The principal disadvantages of the gun are probably these: firstly, it can never be as efficient a demolition agent as a party working at the target laying carefully placed bulk explosive; secondly, gunnery is very much a "funny" as far as the Corps is concerned, and it involves a considerable training problem; thirdly, a traversing gun requires a turret, which dictates the whole shape of the AVRE. And lastly, if the AVRE needs to get close to the target—as it must in some cases—it might seem that rapid demolition devices, placed by hand, could usually be employed instead.

As a short "gap-crosser". The third role of the AVRE is to furnish crossings over small obstacles such as irrigation ditches. The traditional device for this purpose is the fascine—a large bundle of chespaling fastened together with steel wire rope—which is still to be found in the "toybox". Once a fascine has been dropped into the obstacle, it can normally be used at once by tracked vehicles, and the crossing can be improved to take wheeled vehicles by dozing earth over the top of it.

An AVRE cannot be expected to motor about the battlefield with a fascine mounted and ready for instant use because the presence of the fascine severely limits the AVRE's performance. Unless, therefore, the existence of a small obstacle has been foreseen in advance, the AVRE is likely to arrive at it with its fascine at best—if it has one with it at all—in a trailer. Since it takes time to mount the fascine from the trailer, it is very probable that a bridgelayer will be used to effect the crossing instead. It is perhaps fair to say that in normal European country, provided that bridgelayers are available, the fascine will rarely, if ever, be used; but for operations in an area liberally supplied with irrigation ditches, it might well be of considerable value.

Before dismissing fascines, one should mention that they can be split into their component small bundles of chespaling, and that these can be a useful aid for making an improvised pathway for tanks or wheeled vehicles over boggy ground.

Also under the heading of short gap crossing come Armco culverting crossings. Prepared lengths of Armco can be carried either on the AVRE or in a trailer behind it and positioned in the ditch by the crew. The AVRE is then an ideal vehicle to complete the crossing by dozing.

As a towing agent. The fourth role of the AVRE is as a towing agent. Specifically it can tow a 7½ ton GS trailer, the Giant Viper trailer, a rooter, a mechanical minelayer, or a heavy ferry "sledge train"; and no doubt certain other things which Ahmed has not yet thought of.

The 7½ ton GS trailer (Photo 5), normally known simply as the AVRE trailer, is a fairly recent development, and undoubtedly a useful one. It is designed to carry a fascine but is, in fact, a general purpose trailer which is much more frequently used in other ways. Common loads are RDD crates,

Photo. 5. *The AVRE Trailer.* The trailer has a capacity of $7\frac{1}{2}$ tons and an excellent suspension system (Note the heavy coil springs).

RDD hayricks, mines, culverting, 165 mm ammunition, bulk explosive or expedient trackway. Though volume is much more commonly the criterion than the $7\frac{1}{2}$ ton weight limit, the trailer can carry an impressive quantity of stores. The trailer is not generally popular with tank commanders because its presence makes the task of hiding the AVRE in a wood a good deal more difficult than it is already; but the design is excellent and the towing AVRE's performance is limited very little indeed by its presence, even when crossing obstacles.

Little need be said about the other equipments which can be towed by the AVRE, for none of these is peculiar to armoured engineers. The Giant Viper trailer, which is a joint RAC and RE equipment, can be towed and fired equally well by a gun tank or an FV 432; while rooters, mechanical mine-layers and heavy ferry sledge trains can be towed by dozers. Nevertheless, the ability to perform all these functions is an example of the versatility of the equipment.

As a personnel carrier. The last attribute of the AVRE is the somewhat obvious one that it provides cross-country mobility and tank armour protection to its crew of five combat engineers, of whom the senior is normally a Corporal. There is nothing to prevent this crew from dismounting and acting as a small engineer section, and this is frequently done on formation exercises in BAOR. An AVRE crew can lay nuisance mines (carried in their trailer); blow craters (using a camouflet set and explosive again carried in the trailer); form a small basic mine breaching party (they have all the equipment required including a detector actually on the AVRE); destroy a bridge (by normal "deliberate" means, RDD or demolition gun); or take over a reserve demolition prepared by a field section (for they have their own exploder and megger test set). In short they can undertake any combat engineer task that is within the capacity of such a small party, provided, of course, that the necessary stores are available; and, for many of these tasks, additional transport will not be required thanks to the excellent capacity of the AVRE trailer.

The AVRE—a summary. It is fair to say that the capabilities of the AVRE are seldom seen to advantage on major formation exercises in Europe because of the restrictions which have to be imposed in order to limit exercise damage. If the AVRE's three major functions are as a dozer, as a demolition tool and as a short gap-crosser, then exercise limitations virtually emasculate it; for one cannot, for obvious reasons, fire the gun in the European countryside, dozing is very rarely permitted and even irrigation ditches must not be blocked. Only the dismounted functions of the crew, acting as combat engineers, can usually be seen by onlookers.

Nevertheless, one must not be misled by exercise limitations, and it is for the reader—as a past, present or future squadron commander—to decide whether he would, or would not, be glad to have Centurion AVREs (or their successors) available to him when his squadron is supporting an all arms group in European conditions.

Overheads

It would be folly to elect to accept equipment into any type of unit without first examining the logistic and training problems which that equipment brings in its train. And it must be admitted that a unit which has never had tanks on its establishment will find itself saddled, in accepting tanks, with a considerable bill in terms of overheads. The critical question, of course, is whether the advantages of the new equipment will outweigh the bill; and in this connexion, it may fairly be pointed out that a field squadron which has converted from 3-tonners to APCs has already paid a fair part of the account —but not all of it.

The first overhead is replenishment. The fuel tanks of an AVRE or bridgelayer hold forty-nine jerricans of MT 80; the ARK twenty-seven. Fuel consumption may be at the rate of half a jerrican per mile, or even in very bad going, as high as a whole jerrican per mile. The bill in terms of petrol trucks in the squadron echelon will be fairly high. Ammunition for the 165 mm gun adds to the problem, for an AVRE needs thirty rounds to "bomb up" and these thirty rounds will fill half a 3-tonner.

Secondly, a sizeable LAD will be required for repairs. It must contain several "A" vehicle mechanics, at least one control equipment technician (principally for bridgelayer "electrics") and, if the AVRE gun is to be retained, a gun fitter. It must also include an ARV and recovery mechanics. FAMTO holdings are much higher for Centurions than for FV 432s, which will add to the bill for binned trucks and storemen.

One of the most difficult overheads is the training problem. One cannot afford to train each man in a tank crew to perform just one function; for otherwise the absence of one crewman would have serious consequences. There are two basic crew functions in a bridgelayer or ARK, driving and signalling; and an additional one, gunnery, in the AVRE. The principle usually adopted is to train every crew member in at least two basic functions; while the tank commander should, in addition, learn the third function (where appropriate), and achieve a higher standard in at least one function than the rest of his crew. As if this were not enough, the crew must be trained as combat engineers. When one adds to this individual training requirement the crew, troop and squadron training needed to ensure an efficient all-round performance, the effort involved is, of course, considerable.

A Summary of the Case

The argument may be presented as follows:—

(*a*) Since field squadrons are commoner than armoured engineer squadrons, it is inevitable that any one brigade will be supported more by field squadrons than by armoured engineers.

(*b*) Fields squadrons must be provided with the best possible equipment to enable them to fulfil their role.

(*c*) In terms of rapid gap crossing the bridgelayer and Ark are possibly (Ahmed says *certainly*) the best equipment; and if this is true then field squadrons should have these vehicles as an integral part of their organization.

(*d*) In terms of a general purpose engineer tool, the AVRE and trailer may be the best equipment available for several tasks; and if this is true then these also should join the field squadron.

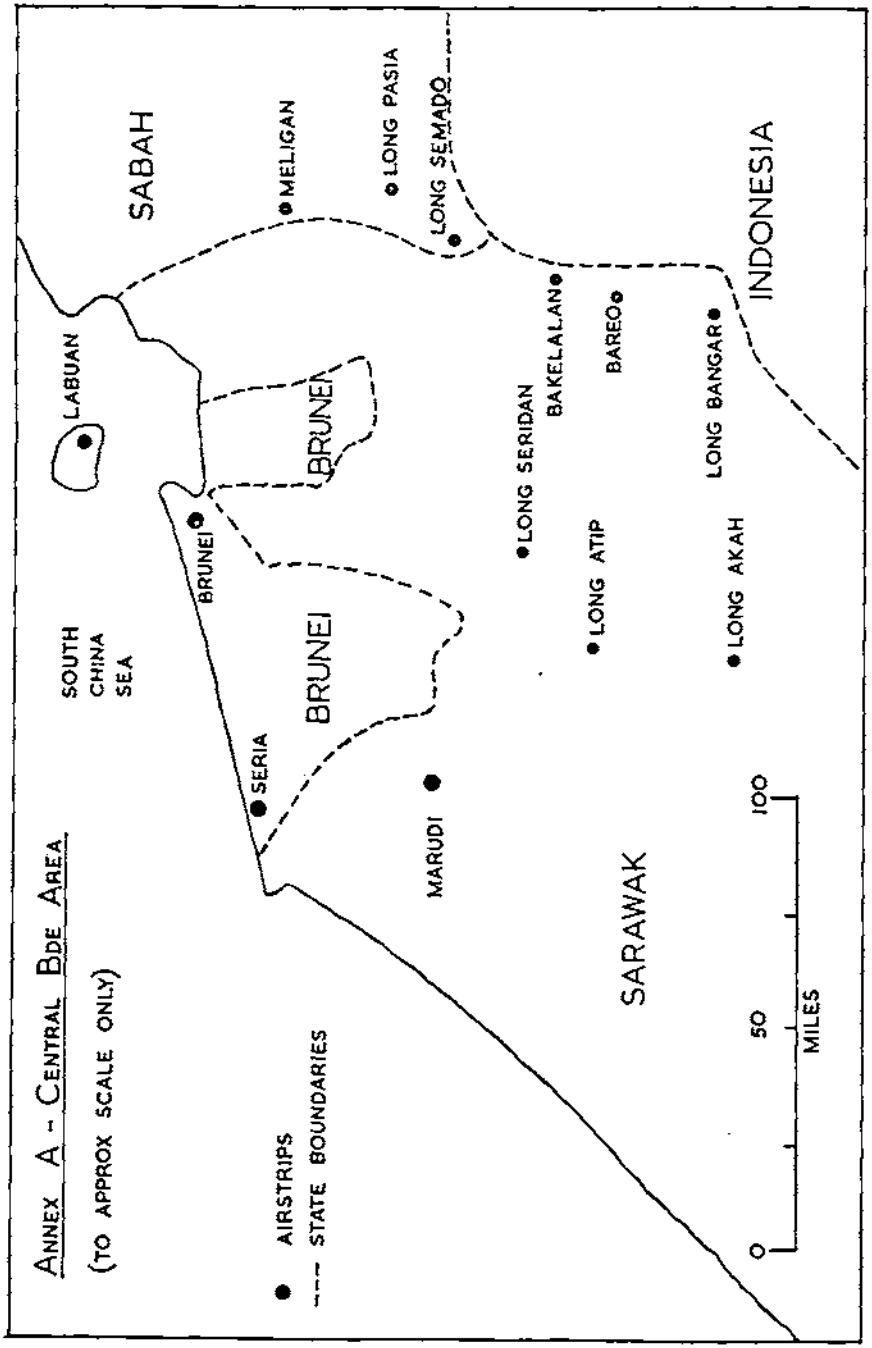
The End of the Parable

Ahmed is displeased with me for presenting what he describes as a half-hearted case. His view is that the summary just given, had it been more positive in tone, should be a complete argument in itself. In a somewhat Churchillian manner he has informed me that the difficulties will take care of themselves and that the necessary changes must start at once. He accepts quite willingly that this would involve the disappearance of armoured engineer units as such. As far as he is concerned this is how the parable should end: with the re-distribution of his treasured playthings among the family and, astonishing though it may seem, his self-immolation. Well, I said he was different.

Whatever the reader thinks of Ahmed's proposal, at least perhaps all can agree that washing should be regarded as just as important as French and music.

Acknowledgement

I am most grateful to Captain (QM) F. F. Giles, RE, who provided me with four of the five photographs; and to Lieutenant R. Lean-Vercoe, RE, who supplied the other.


ANNEX A - CENTRAL BDE AREA
(TO APPROX SCALE ONLY)
● AIRSTRIPS
--- STATE BOUNDARIES
SABAH
MELIGAN
LONG PASIA
LONG SEMADO
INDONESIA
LABUAN
BRUNEI
BAKELALAN
BAREO
LONG BANGAR
LONG SERIDAN
BRUNEI
LONG ATIP
LONG AKAH
SOUTH CHINA SEA
BRUNEI
SERIA
MARUDI
SARAWAK
0
50
100
MILES

Borneo 1966

By Major R. A. S. Rickets, RE

After two tours in Germany it was a tremendous change to come back to the Far East and join a squadron hard at work in Borneo early in 1966. It was also quite a challenge to come to a Gurkha Engineer squadron as, although I had known many of the Gurkha Engineers in Malaya some years previously, I had never been one of them.

Confrontation ended six months later, the withdrawal went faster than anyone could have forecast and by November 1966, we were the only British squadron in Borneo, based in Brunei State, where we remain.

Our CRE was very keen that something should go on record and that we should set out all the many lessons we had learned rather than have to learn them all over again at some future date. I got out of this one by hinting that I intended writing an article for the *Journal* anyway, which was not strictly true at the time. The moral is all too plain—never volunteer for anything!

It would be boring to set out all the various jobs done in detail. All I can hope to do is to give an idea, to those people who have not done this sort of work, of the conditions they can expect and the work they will be faced with if they are lucky enough to get a similar opportunity. It is in fact the story of 67 Gurkha Independent Field Squadron from January 1966 until the following November.

The other squadrons in Borneo, both British and Malaysian, were doing much the same work with different shades of emphasis. We differed really in only two respects. We were in Borneo on an accompanied two year tour. The other squadrons worked the roster of six months unaccompanied in Borneo and six months with their families in West Malaysia. Our area was supplied entirely by air and we had no road-building tasks. In the other areas roads were very much part of the job.

And so to begin: the Squadron relieved "69", one of its sister squadrons, in the Central Brigade area soon after Christmas. The base was Seria, on the coast of Brunei State. The families moved into very pleasant bungalows and Squadron HQ into a permanent camp, all by arrangement with the Shell Oil Company. This part of the coast, some seven miles of reclaimed land is the home and base of the Shell Company in North Borneo and offers most of the facilities one could wish for including swimming pools, sports pitches, sailing and rowing, a golf course and the two luxurious clubs, though we had little chance to use them at the time.

The field troops were deployed straight away into the forward areas where they continued to work for the next nine months, the married men being brought back once a month whenever possible to spend two or three days with their families.

To save a lot of explanation, you should find at Annex 'A' a rough sketch map of what was the Central Brigade area, 30,000 square miles of jungle bounded to the north by the sea, to east and west by other brigades, and to the south by the Indonesian border. For our purposes the state boundaries between Brunei, Sarawak and Sabah were ignored except where a project was paid for by a particular state. Apart from the narrow coastal belt, which is flat and swampy, the rest of this area is a plateau of jagged ridges, steep valleys and fast-running streams, all covered and hidden by jungle. The height ranges from 3,000 to 8,000 ft above sea level and the peaks are often in cloud. The only roads are along the coast and much of the interior is not yet accurately mapped.

Scattered along the valleys are the longhouses of the few people who live here, primitive tribes most of whom have never seen the outside world. Where airstrips have been built, missionaries and doctors visit them regularly and some now have their own schools, but in the main they are hardly changed from centuries ago. They are a friendly and most hospitable people.

HQ Director of Borneo Operations was on Labuan Island off the Brunei coast and Central Brigade HQ in Brunei Town. Both had excellent airstrips with permanent runways.

The forward bases of the infantry battalions were stretched along 300 miles of the Indonesian border, covering the main valley approaches. From these bases, the forward areas were completely dominated by intensive patrolling and artillery fire. Based with the battalions were Wessex and Whirlwind helicopters of the Royal Navy and RAF, and their own light Sioux. All movement of men and supplies between the coast and the forward bases was by air, Beverleys from Labuan doing the air-drops, and Single and Twin Pioneers, Beavers, Scouts, Wessexes and Whirlwinds air-landing the rest. One soon became used to spending a lot of one's time in an aircraft, usually crammed between the eggs, the bread and the mail, and looking for the flights of hornbills gliding over the tree-tops. Frequently the high ground was in cloud, when the only thing to do was concentrate on something else, tighten the stomach muscles, hold on and trust the pilot.

A word about the command set-up is probably worth while. With all the other squadrons in Borneo, we were under command of the CRE who had his HQ in Labuan. He placed us in support of Central Brigade less two troops who were on force projects, and we were under command of Central Brigade for administration. As both Force projects were in the Central Brigade area, we were in effect the Central Brigade support squadron with two troops on specific engineer tasks. This worked very happily and we obtained all our engineer resources and engineer assistance through the CRE, while proudly brandishing our Central Brigade flashes, the crossed Kukri on green backing.

Discounting about a hundred men away on Nepal leave, courses and various ERE and ESE appointments, we had a working strength of 250 organized as usual into HQ and MT, Park Troop and three field troops. Apart from two landrovers flown into a forward base for use as load carriers, the transport stayed in Seria, much of it on a care and maintenance basis, and also our own plant. The plant operators were forward the whole time using airportable pool plant. The Stores Section of Park Troop ceased to exist as our resources were handled by the RE Resources Detachment at Brunei. The Workshop Section also ran down to nothing. The constant aim was to get more men up with the field troops.

There were several means of communication in all directions. The usual means to Brunei and Labuan was by civil telephone, the delay varying with the civil operators. From Seria to Brunei by road was a ninety minute drive. From Brigade HQ, any message could be passed quickly by radio to the forward infantry units and to our troops working with them, and we maintained a rear link on the Brigade radio net all the time. In fact all our traffic for our own forward troops went over our own forward net which was open ten hours a day for the whole nine months and in spite of the distance and atmospheric conditions maintained voice contact for most of the daylight hours. This net was always busy carrying all our engineer and administrative traffic.

The forward troops were usually rationed by the infantry they lived with, but their maintenance demands, which came in by radio, were processed by the SQMS. These included NAAFI canteen supplies, any special individual requirements on repayment, replacement or new tools and equipment and clothing. Delivery was arranged by air from Labuan or Brunei. NAAFI goods were air-dropped with their invoices, payment agreed by the troops and made by Squadron HQ, and the troop or individuals charged later. Quite a headache for the 2 IC.

Bids for all project stores were also made through Squadron HQ where the Clerk of Works arranged delivery with the Resources Detachment or HQ RE and accounted for all expenditure. A lot of project stores were bought through local contractors and frequently had to be shipped across to Labuan for air-dropping.

So far, I have written fairly aimlessly on general background. I shall go on now to the work we did and will also start using headings.

Engineer Work—General

As the Brigade depended entirely on air supply, our first priority was to improve this facility by opening new airstrips, dropping zones and landing pads and maintaining the old ones. As the forward battalions were so isolated, our second priority was to make life as comfortable as possible for them by steadily improving their camps and maintaining them. After this came various small tasks in the Hearts and Minds campaign, such as water supply and suspension footbridges for the local inhabitants. Occasionally, we had tasks in direct support of the infantry. When Confrontation ended, we went smartly into reverse, dismantling those positions which were not required by the Malaysian forces.

The New Camp at Bareo

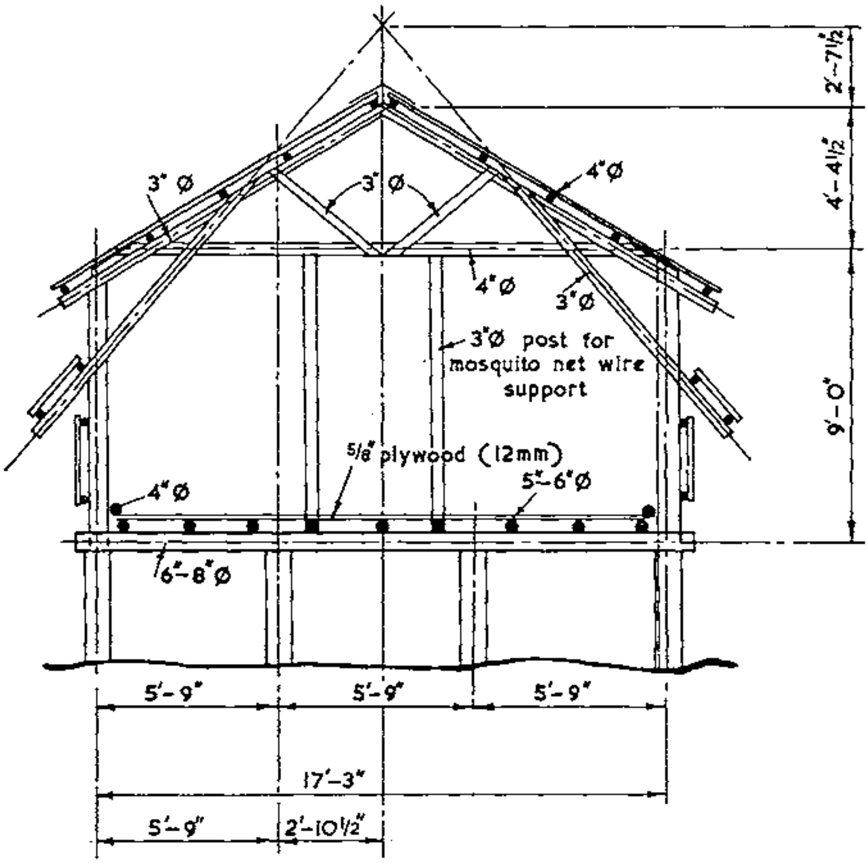
Bareo is some eight miles from the Indonesian border and the home of the Kelabits. The longhouse accommodates 600 people and stands in a large, open and well-cultivated valley. Here the Kelabits, in almost complete isolation, developed rice-growing well in advance of most of the North Borneo peoples. When Tom Harrisson parachuted into this valley in 1945 to organize resistance against the Japanese, he found "a whole community living inside one great longhouse, without walls, without privacy, but with an immense virility and variety of culture and material wealth and of human personality."

Around the corner of the valley is a grass airstrip 1,800 ft long, built by hand under the supervision of the District Officer in 1960. This was the main base of one of the battalions, a straggle of huts and dugouts, along one side of the airstrip with outlying platoon positions on the near-by hill tops.

The requirement here was to build a new camp on the hillside overlooking the old one. A Clerk of Works (Construction), WO II (now WO I) Cartin, was sent to help. He later became involved in many of our other tasks too and proved just how valuable a clerk of works can be. The design, layout and

ANNEX B

CROSS SECTION OF STANDARD BAY
JUNGLE TIMBER AND C.G.I.



TRUSSES AT 10'-0" ℄   SCALE:— ¼" TO 1'-0" siting were agreed, the works programme made out and the stores listed and priced. Mr Cartin gave the EDC as 29 September, which proved uncannily accurate in the event.

C Troop had just completed another large camp and started work on the Bareo project in February.

The new camp was to comprise sixty-nine buildings in all with mains electricity throughout from a 27½ KVA generator. Hot and cold water was to be provided for all ablutions and showers and these, with the cookhouses and toilets were to have concrete floors. It was decided to pump water through the twin Farelf filters to Sandakan tank storage, thence to be gravity fed to each part of the camp. Water heating was to be by the usual oil-fired home-made boilers already used in most of the camps, made up in part by contractors and in part on the spot with empty 44 gallon fuel drums. There was to be a helipad complex of seven Wessex pads and the normal refuelling pads and workshop facilities.

The obvious way to build was on a production line basis using a standard bay for all huts. The only variation was the number of bays per hut and the flooring. Huts not to be concreted were to have ⅝ in thick plywood sheet floors and stand on piles clear of the ground. The standard bays were of jungle timber frames roofed and clad with CGI. The basic design is shown at Annex 'B'. It can be adapted to many different layouts, as was shown by the British Officers' Mess, built in three sides of a square on a steep slope with the balcony 20 ft above ground overlooking the valley.

Some forty civilians were employed from the area on this project, most of them from the Bareo longhouse, and were paid M$4.00 a day. These men, and a few women too, joined wholeheartedly in the work and the troop quickly settled down to a number of small teams, soldiers supervising civilians and doing the tricky jobs, civilians doing the less skilled work. Very soon all were expert at their part of the building programme.

The first requirement was a steady flow of good straight jungle timber. An old footpath running 3 miles into swampy jungle was widened, drained and given a corduroy surface to take a landrover. The landrover was then flown in with its trailer and for the next three months bumped and bounced up and down the track carrying up to a ton of timber a time, until finally it bounced off the track altogether to its last resting place where perhaps in centuries to come it will be found as an example from our bygone age. You should try filling in a traffic accident report for an accident where no road officially exists, least of all traffic lights, and then explaining why your MT Standing Orders don't quite cover you. It was replaced and work continued. In the meantime, a helicopter stood in.

The timber collectors cut the trees, trimmed them, removed the bark and stacked them on the track. The rover party hauled them to the middle of the new camp, where another party made up the hut frames on a template, and oil-soaked the piles. A clearance party surveyed in each hut in detail and cleared the undergrowth. The pile party then dug in the piles and levelled them. On steep slopes some were 20 ft high. Next came the frame party, putting up the frames and purlins and finally the roofers and cladders, the flooring party and the electricians. Completed huts appeared at an astonishing rate.

It will be appreciated that the project depended entirely on air-supply for all stores other than jungle timber. The flow was based on the original stores lists and works programme and there were very few hiccups. Really early planning was necessary, particularly as many stores had to be bought from contractors and tenders take time. The heavy stores were air-dropped, the rest air-landed. To give an idea of the quantities involved, some 21,000 sheets of CGI alone were delivered.

As work progressed, a need for sawn timber arose for cladding some of the more spectacular buildings. The saw trailer was flown in, a hut built at the end of the timber track and one hundred planks a day were cut.

The first and only real problem was the provision of stone for concreting. There was nothing harder than soft sandstone in the valley. Quite by chance, an isolated outcrop of quite good stone was found, ¾ mile off to one side of the timber track, 2½ miles from the camp, in very wet swampy jungle. How or why it had got there no one could guess, but we only needed 40 cu yds and it offered a lot more than that. The face was some 50 ft high by 100 ft wide, and it ran for 200 yds. It would cost $3,000 to employ extra labour and build a track to it. Thirty civilians were put to work and in three weeks had completed a splendid corduroy track ¾ mile long and 20 ft wide, including three bridges, one of which was 100 ft long. You cannot beat these chaps when it comes to clearing jungle and cutting timber.

A stonecrusher, elevator, compressor and drills, a Ferguson 203 with front and back end equipment and a Ferguson trailer were flown in from Brunei, and out came the stone, C Troop doing a very nice blasting job which dropped all that we needed in one go.

At about the same time, the little Bristol 404 dozer was flown in to help track construction.

In wet weather, the old airstrip surface was being broken up by the daily heavy drops. Using more local labour, a dropping zone 200 × 100 yds was cleared on the far hillside and a PSP track laid to it.

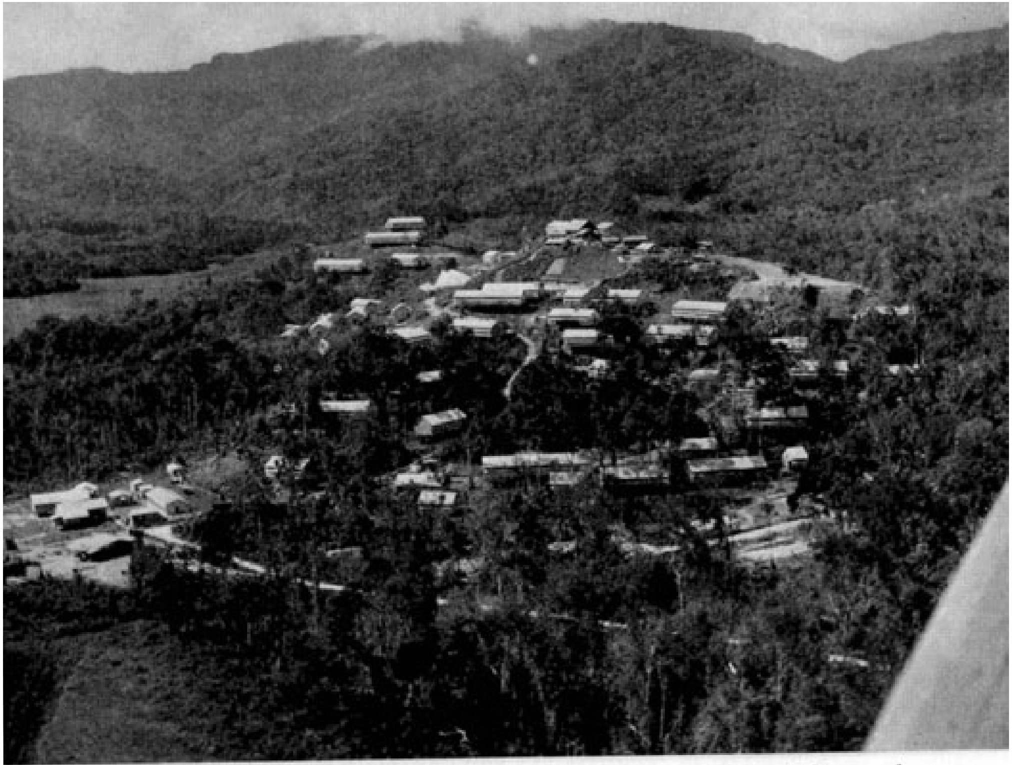
By August, the camp was nearing completion and the time had come to start wiring it. We formed up a team of one Clerk of Works (Electrical) from 522 STRE, four of our own electricians, two borrowed from 68 Squadron in Kuching, and three from 69 Squadron in Hong Kong. In five weeks, the whole job was completed and the electricians had some most useful training.

When Confrontation suddenly ended, the whole future of the project came in doubt. Determined to finish the job, C Troop went on building. In the event, the camp was completed and handed over to Malaysian forces. By the end of September, C Troop and the plant and stores were back in Seria. They had been nine months in the forward areas without a break and had earned a rest.

Long Pasia—A Troop

Our other main project concurrent with the Bareo Camp was an airstrip at Long Pasia, 80 miles south-east of Brunei and 50 miles north-east of Bareo. A strip had been built here in 1964 but the grass surface had collapsed. The requirement was for a stone-surfaced strip, 1,800 ft long. It involved completely reshaping the old "formation", compacting it, laying and compacting 4 in of crushed stone, constructing a completely new drainage system including two culverts right under the strip and reshaping and grassing the shoulders and verges.

'A' Troop started this in February 1966 and finished in September. They



Bareo new camp, September '66, with the timber track visible through the trees in foreground.

Borneo 1966 1

C Troop waiting to leave Bareo complete with buffalo for Dasera. September '66.

Borneo 1966 2

took over the plant left by 69 Squadron—all light and airportable and consequently slow to work with, but nothing bigger could be flown in. There were two old D4 dozers giving constant trouble with breakdowns, two Fordson Super Majors, two Michigan 230s with front and back end equipments, a Greens vibrating roller, a wobbly-wheeled roller, Morewear dumper, stone crusher and elevator. The Trans-Atlas grader mounted on the Fordson had proved quite hopeless, but in April the new Allis Chalmers light grader arrived, to earn itself the profound respect of everyone throughout the remaining five months. A third D4 was flown in in the hope that with three of these old machines we might succeed in keeping two on the road. The troop employed some forty civilian labourers daily until they became impossible to get in the padi season.

The source of stone was the bed of the river running alongside the strip. In dry weather, with the water level low, a dozer worked in the river piling up boulders which were then lifted into the Morewear dumper, using the front bucket of the Ferguson 203. These were stockpiled at the crushing site and hand fed into the crusher which was set up in a pit to ease loading. The crushed stone then went up on an elevator belt to the crushed stockpile on the far side of the pit, and from here was dozed into a hopper above a second pit. The dumper then drove into the second pit beneath the hopper for loading, and took the stone on to the strip. In wet weather, the river quickly became a torrent and stone-winning became impossible.

The biggest problem in construction of this type in Borneo is drainage. Heavy rain really is heavy and will wash away all but the most carefully laid plans. In this case, the main side drains were "V" ditches, which at the runouts were 20 ft deep and 50 ft wide at the top. Such ditches, unless concreted, require constant maintenance to remove the sand and silt deposited by torrents of water running into them during a rainstorm. Even the most gentle slope must be well consolidated and strengthened by planting grass or pegging. On a grass verge sloped at more than 1 : 100, the running water will quickly wash away the fine soil, leaving only tufts of grass sticking up every few feet, unless steps are taken to slow down the flow.

Most of us have probably learned the hard way how important it is to compact thoroughly and how much extra work can result from using plant on wet ground. The temptation always is to press on. If the new surface is not thoroughly compacted, at every level, trouble will always ensue, and if plant is used before the ground is properly dried, more work will result.

The final surface at Long Pasia was 4 in of crushed stone rolled to a hard finish. It gave a splendid landing surface and stood up well to the fully loaded Caribou. The disadvantage of this type of surface is that it must be maintained. An aircraft landing wheel coming down hard will loosen the stone at that point. After several landings this will spread. By rolling regularly, once a week where two or three landings a day are expected, the strip can be kept in perfect condition.

A dropping zone was cleared and a stone track laid to it, and an aircraft parking area built to the same specification as the strip. If drops are taken on the strip itself, they will always disrupt the surface. It is essential to clear a separate dropping zone.

This project was completed in September. 'A' troop had been at Long Pasia for eight months.

Brigade Tasks—'B' Troop

General. 'B' Troop was the Brigade Support Troop throughout this period. They carried out a variety of tasks throughout the Brigade area, usually with detachments in several places at once. They cleared helicopter landing zones, and dropping zones and built helipads, and a variety of huts for accommodation, stores and workshops, laid concrete, put in new water and electricity systems, and apart from two weeks in Seria, remained in the forward areas the whole time. Two subjects worth discussing here are camp maintenance and water supply.

Camp maintenance. The Squadron had the responsibility of maintaining all the forward camps in the Brigade area, a task likely to come the way of any squadron in a similar situation. An annual allotment of $80,000 was made for this work which did not include any new services. The job split three ways. The first was the provision of replacement maintenance items such as refrigerator glasses. Demands were submitted by units to the Squadron, to be authorized and accounted for, and provision then arranged through RE Resources Detachment. It was soon apparent that new refrigerator glasses alone would use up a great deal of our maintenance money for the year. The second part of the task was the provision of materials, particularly concrete and CGI, for self-help camp improvements and the third included camp improvements or repairs to be done by the Squadron. The provision of all stores and their accounting was controlled by the Clerk of Works (Construction), attached to us for the Bareo project. Again he proved the need for, and value of, a Clerk of Works in such situations.

Water supply. When we took over the area, water supply in the forward bases was by Alcon pump through the single Farelf filter. Storage was by multiples of inter-connected 44 gallon drums on jungle timber towers. This was the best means available at the time, but the systems were inefficient and inconvenient. The Alcon pumps were constantly breaking down. The single Farelf filter could not meet the requirement of filtered water. Storage was inconvenient for chlorination.

The requirement was 20 gallons of water per man per day and all water was to be filtered and chlorinated. By August, every base had a new system which more than met the requirement. The Alcon pumps were replaced with No 4 pumping sets, which proved well able to stand the strain of constant pumping over long periods. Double Farelf filters were installed to increase output. Forty-four gallon drums storage was replaced by 400 gallon galvanized tanks parachuted in, and all layouts were improved.

The No 4 pumping set connected to the double Farelf filter will produce 1,000 gallons an hr, allowing for backflushing, and this at times was necessary every 15 min. In the average base, it was necessary to pump for 4 hrs a day.

The one factor which cannot be calculated in water supply is the efficiency of the operator. In this case, the water dutymen were provided by the infantry companies who were responsible for operating the systems we installed. It is a miserable job to pump and backflush, pump and backflush, day after day after day. Too often, we found that the filters had been by-passed, either because the operator did not understand what he was doing, or simply to avoid the bother of backflushing. In these circumstances, it will always need constant effort by the sappers to see that the infantry units understand the systems given to them and use them properly.

Control organization. Throughout this period the Squadron Second-in-Command was tied to administration and accounting, with little time for anything else. Some funds were accountable to the Sabah Government, others to the Sarawak Government, to Brigade Headquarters, to CRE and to the Command Paymaster. Repayment for NAAFI stores alone took much of his time.

With no other officer in Squadron HQ, the Squadron Commander was left with most of the day-to-day project and operational matters. If he spent too much time in the forward areas, work piled up in Squadron Headquarters. If he stayed in Seria, he could not keep fully in the picture except from radio sitreps. In this situation, there is a definite need for another officer in Squadron Headquarters, to relieve the 2 IC of his administrative duties and free him to run the operations office. This is essential for continuity and proper control.

Conclusions

We have of course learned so many lessons that I could not hope to cover them all here. To conclude, I am going to pick out two which to my mind stand out above all others. They are as follows:—

(*a*) *The value of clerks of works.* In Central Brigade, our Clerk of Works (Construction) was invaluable. Apart from the assistance he gave us in planning and costing projects, he knew the best stores for the job and how to get them and account for them. A troop commander does not have this detailed knowledge or the experience. The Clerk of Works is completely at home. He knows what Resources have in their military stocks, what the contractors can provide and how long it will take, and very often he can cut the corners and get things in a hurry when needed. How many of us can say what sizes of water taps can be had on the local market and what they cost, without having to waste time finding out?

(*b*) *The value of civilian labour.* In almost every task we were given we were able to hire civilians for manual work. In the jungle these people are expert at cutting and felling timber and clearing undergrowth. Properly supervised, they are quite capable of laying corduroy track or PSP, digging drainage ditches, making hut frames and ours in one case even operated a sawmill. They leave the troop free of menial tasks. Every soldier becomes a supervisor or works at his trade. Forty civilians will more than double the potential of a troop.

Afterthought

Some months have already gone by since Confrontation ended. The withdrawal, once started, was well-organized and fast, thanks to good staff planning and the tremendous efforts of the pilots and ground crews. We did what we could to help the battalions get clear, stripping those old camps which were not wanted by the Malaysian forces, blowing up bunkers and generally tidying up. The old camp at Bareo was completely removed and all the old dugouts and defences levelled in five days by a detachment of B Troop with over a hundred Kelabit helpers. This detachment was the last of the British Army to leave the forward areas.

At the same time, we had to get all our own men, stores and plant back to Seria. The plant was dismantled by our own fitters and flown out in forty Wessex helicopter lifts to Brunei. Here we had a team from 54 Corps Field Park Squadron, borrowed from Singapore. In eight days, it was cleaned, painted, repaired, reassembled and tested. The old D4, however, were missing. They had been written off and found their last resting place at Long Pasia.

The Squadron stays on in Seria and after a good rest and some retraining we are back at work, but the pressure is off, the airstrips are deserted and life is quiet. Our formation headquarters is a thousand miles away in Singapore. On the stocks we have nine concrete basketball pitches, a Romney hangar and workshops, a couple of classroom buildings, a war memorial, a landing ramp, a rifle range, a bailey bridge and a road project. The beer is cheap too. What more could one ask?

Officers of 67 Gurkha Independent Field Squadron
January–November 1966

OC	Major G. G. Roach, RE Major R. A. Rickets, RE
2 IC	Major J. S. Nobbs, MBE, RE Captain D. Verschoyle, RE
Troop Commanders	
'A' Troop (Long Pasia)	Captain D. Verschoyle, RE Captain N. Tomlinson, RE Lieut G. Oxley, RE
'B' Troop (BDE Support)	Lieut J. Forbes, RE Lieut J. Hewitt, RE
'C' Troop (Sepulot, Bareo)	Captain P. Reedman, RE
Squadron Gurkha Captain	Captain (QGO) Dhojbir Limbu, MVO
Squadron Gurkha Officers	Lieut (QGO) Kesarbahadur Limbu Lieut (QGO) Churamani Thapa Lieut (QGO) Partapsing Thapa Lieut (QGO) Krishnabahadur Tamang Lieut (QGO) Dhane Gurung

Detection of Underground Objects by Divining

By Major D. P. Cadoux-Hudson, RE

Divining or dowsing is usually associated with men possessing very special powers walking round a field with a hazel fork in their hands looking for hidden sources of water. The whole business has been surrounded by an aura of the supernatural and confined only to the chosen few who form a select and exclusive club. This exclusiveness is to some extent perpetuated, because whenever one really wants to find water and try one's powers at this rather esoteric sport, the countryside is, as often as not, too dry or too hot to grow hazel bushes anyway. The whole thing becomes too difficult and fades from the mind almost at once.

Experiments which I have recently carried out clearly show that almost everyone can dowse, and can do it extremely well. Furthermore, water is by no means the only thing that can be detected beneath the ground. The fact is that anything unusual beneath the ground can be accurately located; moreover, the size of the object, the material from which it is made, and its depth can readily be determined by the beginner after only a very little practice. The everyday applications of this are legion. Drains, water pipes, electric cables and even voids can be found; plant operators can themselves check the site for underground cables before starting to work; water sources can be found as can even small items like lost valuables.

All that is needed is two bits of wire bent into an L shape. The short bit of the L should be about six inches long and the longer bit about twelve to eighteen inches long. Wire from coathangers used by cleaners serves admirably but ordinary 14 gauge wire will do. With each hand shaped as for holding a pint beer mug the shorter bits of the L are held vertically and lightly in the hands, whilst the long bits are made to point out horizontally in front and parallel to each other. Divining can now begin. This is done simply by moving forward at a slow walking pace with the forearms parallel to the ground and the whole body perfectly relaxed. When over an object the wires will swing inwards and cross, ending up right across the body; with a very few people the wires swing outwards, and, regrettably, with even fewer nothing happens at all. Once the wires have crossed right over, the object will be directly under the feet. (This fact, rather naturally, renders the method inappropriate for the detection of antipersonnel mines.)

To find the depth of an object the movement of the wires must be watched. As soon as they start to move together a mark is placed on the ground and another mark is put down when they are fully crossed. The distance between these two marks is the depth of the object below the surface.

The nature of the substance can be found from the interesting fact that if something of the same substance is held in the hand next to the wire no movement of the wires takes place as the object is passed. This can readily be demonstrated by putting a penny on the ground and divining for it while holding another penny in the hand. If, therefore, one has a variety of bits and pieces of copper, steel, earthenware and concrete handy whilst divining it is possible to say for sure what the object that has been detected is made of. A polythene tube of water can be made to confirm water and an empty polythene tube can be made to confirm a void.

The size of the object can be ascertained after a little practice by taking readings from various opposite directions and noting where the wires finally cross. With pipes and drains an accuracy of an inch or two either way can be expected. In addition, a drain or pipe can be followed by walking along it. If one is over the pipe and walking along its length the wires point straight ahead. If one wanders off to the right the wires point left and vice versa. Thus, once a pipe is found its course between two points can quickly be traced.

Training soldiers to dowse can be done very rapidly. The author trained a band of six men selected at random from 146 (Antrim Artillery) Engr Regt (TA) to use the wires with confidence and accuracy. After only fifteen minutes of practice they were able to trace drains and water pipes buried as much as twelve feet below the surface within an open space in their barrack area. Later that day they were taken out to the Black Bog, an extensive bog which lies between Omagh and Cookstown in Co Tyrone, in an attempt to find a piece of equipment that fell into it during a TA airborne exercise. The object must have fallen from about 500 ft which meant that it would be some seven feet below the surface of the bog. The area within which the search was to be carried out was large since the spot where the equipment had dropped could not be defined with any accuracy.

An area 200 yds by 200 yds was selected as being the most likely and was divided into strips and searched in successive sweeps, unfortunately without success. However, many other objects made of iron, wood and iron, earthenware, etc, were located at depths of up to nine feet and their presence was confirmed by prodding with long steel rods, and digging.

The accuracy and certainty with which these men after such short practice could handle the dowsing wires and find buried objects so far below the surface more than compensated for the fact that the piece of equipment for which we were looking could not be found.

Here, clearly, is a thoroughly practical, simple and useful skill which can be taught to soldiers without any special equipment and in a very short space of time. Its uses are boundless.

I have no idea what causes this curious phenomenon to occur and would be most interested to hear of any explanation. It would appear to be something to do with the electro-static force of the body reacting with that of the earth. Some say it is to do with the cutting of the earth's magnetic field, but if this was so it would be difficult to explain why it works in precisely the same way regardless of the compass bearing that one is walking. The fact remains that it works, and in an age of increasing complexity and technology it is refreshing to find a detector which is simple, soldier-proof and at the same time highly accurate and that can be made from only 3 ft of G 1098 wire or demolition cable.

Centenary of New Zealand Army Engineers

Engineers in the Tauranga Bush Campaign 1867

By Lieut-Colonel K. C. Fenton, BE (Civil), MNZIE, RNZE
Chief Engineer, Royal New Zealand Engineers

Introduction

Early in 1867 New Zealand Engineer Volunteers took part in the Tauranga Bush Campaign against Hauhau adherents of the Piri-Rakau and Ngati-porou tribes. These Maoris came into conflict with the Government Forces over the question of land confiscation in the Tauranga District, the land having been conceded previously by the Maoris as reparation following the Ngaiterangi rebellion in 1866.

Tauranga is a city located on the east coast of the North Island of New Zealand. It possesses a fine natural harbour, the advantages of which were recognized early in the development of New Zealand by whalers of the 1830s. The bush covered tableland, known as the Hautere Plateau, which lies to the rear of Tauranga Harbour was the location of the series of skirmishes which comprised the campaign.

Although New Zealand citizens took part in military engineering activities in New Zealand prior to 1867, it was in the Tauranga Campaign that a formed unit of New Zealand Engineers was first engaged on operations. The Corps of Royal New Zealand Engineers in 1967 has celebrated the hundredth anniversary of this campaign and a first hundred years of active service by formed military engineer units raised in New Zealand.

The Volunteer System

In the 1850s the total number of Europeans in New Zealand had increased to about 60,000, and relations between Maori and European were deteriorating. Several influential Maori chiefs organized a movement to establish a Maori King and tribes resisted the sale of land. Aware of impending trouble, the New Zealand Government took steps to increase its military preparedness.

In 1858, the second Parliament to be elected in the then Colony passed a Militia and Volunteer Act. While militia were recruited compulsorily for service within their local militia district, volunteers enlisted to fight anywhere in New Zealand and provided their own uniforms, equipment, weapons and ammunition. They appointed their own officers by popular election and made rules and regulations governing their own companies.

No engineer volunteer or militia unit had been formed prior to 1865 but in that year a new act, the Volunteer Act 1865, was passed. It defined a "Corps" as a troop or company of Artillery, a troop of Cavalry, a company of Engineers, a Rifle company, a company of Naval Volunteers or a Fire Brigade! Under the provisions of the Act, in the election of officers, half the corps had to approve the appointment. No member, except "with his own consent or in case of emergency", could be compelled to serve more than 20 miles from his headquarters.

During 1865 interest in volunteering was high in the Colony, and in that year the Canterbury Engineer Volunteers, were formed at Christchurch in the South Island. On 28 April 1866, His Excellency the Governor General accepted the services of the Auckland Engineer Volunteers with effect from 15 March 1866. It was this unit which was engaged in the Tauranga Campaign of 1867, the Canterbury Volunteers never being required to take part in any action against the Maoris.

The Hau Hau Cult

Before the activities of the Auckland Engineer Volunteers in the Tauranga Campaign are followed in detail, it is worth while to trace the events preceding the campaign and the rise of the Hau Hau cult.

The rebel tribes supporting the Maori King movement had been defeated by early 1865 but complete pacification of the Maoris had not been achieved. An uneasy peace ensued with confiscated lands settled by large bodies of drilled men.

Early in 1865, a Maori prophet named Te Ua became the leader of a religious movement known as Hau Hauism. This cult captured the imagination of many Maori tribes, particularly in view of the wide confiscation of Maori land which followed the defeat of the Maori King movement. Te Ua claimed to be in contact with the Angel Gabriel and believed he had been chosen by God to drive the Europeans from his country. Appealing to the nature of the Maoris of that time, Hau Hauism spread rapidly and two of Te Ua's followers, sent to the East Coast, converted disaffected tribesmen there.

Hau Hauism, which appealed to the Maoris' strong love of country and kin, was a blend of ancient faith in spells and incantations with fragments of Christian church services taught by missionaries. The Hau Hau priests claimed supernatural powers and induced their followers to believe that the European (or "pakeha") bullets could be avoided by certain magic spells and by chanting battle hymns. The Maori fighting spirit thus hardened and the resulting "Holy War" was conducted with savagery and fanaticism.

The beginning of the Hau Hau uprisings coincided with the commencement of New Zealand's policy of greater self reliance in military affairs. By 1866, embarkation of Imperial troops had commenced in response to the British Government's recall of troops from Colonial stations. Thus it was the task of locally raised troops to deal with the Hau Hau uprising at Tauranga.

It must be mentioned that some tribes decided to assist the Europeans in dealing with Hau Hau uprisings. These tribes, under the leadership of Colonial Officers, helped materially to bring peace to the North Island where all the uprisings occurred.

Formation of the Auckland Volunteer Engineer Corps

Following the practice of the time, H. L. Skeet, as Honorary Secretary, forwarded the names of forty-two persons, most of whom were surveyors, who offered their services "in the shape of a Volunteer Engineer Company". Included in the list of names was Charles Heaphy, VC.[1] As no Corps of this

[1] Major C. Heaphy of the Auckland Militia was awarded the VC for gallant conduct during an action on the banks of the Mangapiko River on 11 February 1864.

kind existed in the Province of Auckland at that time, the applicants "hoped that the Government would accept their services, being accustomed to, or acquainted with, such works as might be required of an Engineer Corps in a country like New Zealand, for example, building redoubts, mining, making pontoons, roads through swamp etc." The applicants in most cases were able also to act as guides and often as interpreters. At a meeting of the Corps on 8 June 1866 the following were selected as officers of the Auckland Volunteer Engineer Corps:—

H. L. Skeet	Captain and Commanding Officer
G. Winter	Lieutenant
T. Hall	2nd Lieutenant or Ensign

Later in the year, the Governor, Sir George Grey, KCB, approved Skeet's commission as follows:—

His Excellency the Governor has been pleased to make the under-mentioned appointment in the Auckland Volunteer Engineer Corps.

Henry Lufkin Skeet to be Captain.
Date of commission 9 June 1866.

Signed
TM Haultain,
Colonial Defence Office.

21 September 1866

Thus official sanction was given to the appointment of a Commander for New Zealand's first established Engineer unit to take part in operations.

Survey of the Maori Lands

Towards the end of 1866, Captain Skeet was appointed District Surveyor at Tauranga, "liable to the requisition of Lt Col Harrington" who held the dual appointment of District Commander and CO 1st Waikato Regiment.

Initially Captain Skeet contracted a party of five surveyors to survey the Katikati Block near Te Puna but by the end of the year twelve parties were working on the survey of lands confiscated or purchased from the Maoris. The lands being surveyed at the end of 1866 were located in the upper parts of the Wairoa and Waimapu Rivers and to the rear of Te Puna.

As the local Maoris were certain to be hostile, it was envisaged that it would be necessary to employ screening parties. Therefore the following special rates were requested and obtained.

Forest £8 per mile
Fern £4 per mile
Open Traverse £2 per mile
Pegs 1/- each
Angle pegs 1/6 each

The Hauhau faction soon showed hostility by warning the surveyors to leave the district or be killed. They followed up these threats by armed raids on several survey camps, the theodolites of Surveyors H. Graham and W. J. Gundry being carried off by one raiding party. These surveyors barely escaped with their lives. W. J. Gundry had been formally commissioned by 25 January 1867 to replace Thomas Hall who had resigned and Gundry served as Skeet's second-in-command in the skirmishes that followed. The surveyors were now formed into an engineer company supporting the Government Forces which comprised:—

Companies of the 1st Waikato Militia
Friendly Arawa Maoris under command of Major William Mair, New Zealand Cross
Volunteer Engineer Company

Prominent among the Hauhaus was the warrior priest Hakaraia and Pene Taka, the man who was accredited with laying out the Maori entrenchments at the Gate Pa.[1]

Opening of the Campaign

The first action of the campaign occurred on 18 January 1867 at the Maori village of Irihanga; a force moved out from the Omanawa Redoubt for the purpose of covering the arrest of Pene Taka and others of the Ngati Porou, on charges of threatening the surveyors and taking their instruments. This action was indecisive.

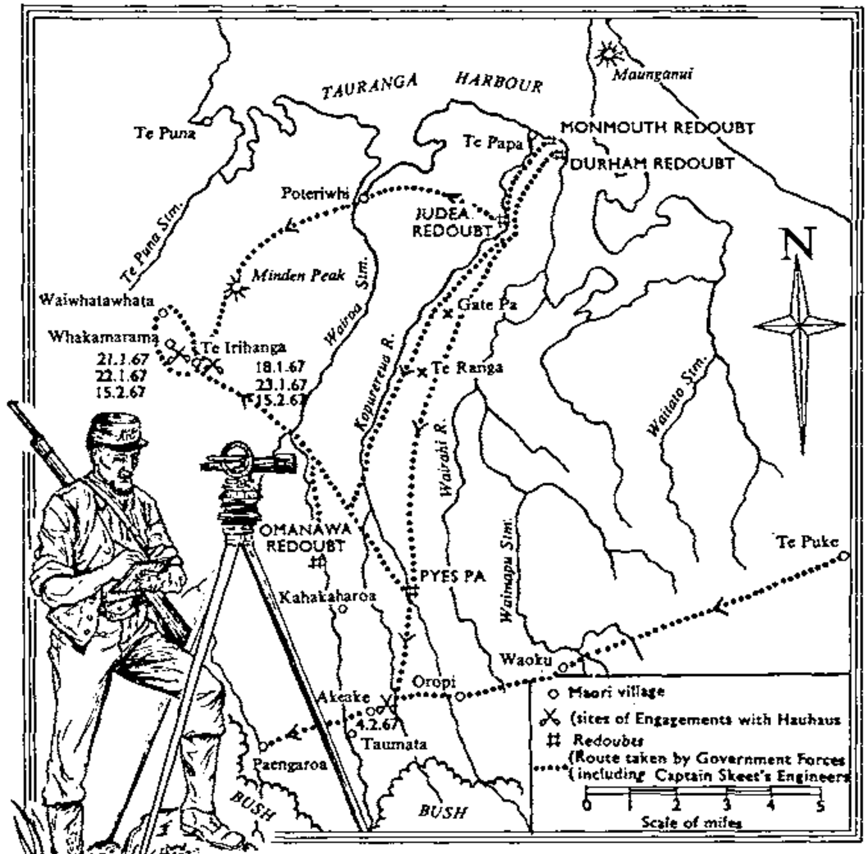
The subsequent actions were aimed at depriving the Maoris of their food supply which was grown at Whakamarama and at breaking the normal line of communication between the Piri-Rakau concentrated at Whakamarama and their allies at Rotorua. Figure 1 shows the routes followed by Government Forces and the battle sites.

"Being well and suitably armed, the engineer company generally led the van and were left to discover and dislodge the enemy who were always well planted and who would allow our force to get pretty near to them before they discovered their presence by a volley."

The second action, commenced on 21 January 1867, when Militia crossed the Wairoa River at Poteriwhi and climbed the fern-clad slopes of Minden Peak (937 ft). Passing through Irihanga, the Militia skirmished through the bush to Whakamarama. Meanwhile Major William Mair raised a force of two hundred armed Arawa at Maketu and after burning Te Puke, the village of the warrior priest Hakaraia, pushed on to Oropi which was also destroyed. On 4 February 1867 with a detachment of the 1st Waikato Militia under Lieut-Colonel Harrington, the engineers attacked the Hauhaus at Ake Ake. Both Ake Ake and near-by Taumatu villages were taken. It was all bush fighting at fairly close quarters; at Ake Ake, Private James Wooley, Engineer Volunteer, was shot in the groin and was nearly tomahawked, being defended by brother engineer Private G. T. Wilkinson until assistance arrived.

Throughout the month the rebels were harassed and the decisive action

[1] The Maori was very skilled as a military engineer and this ability was well illustrated in the Battle for Gate Pa. The site of Gate Pa is about 8½ miles from Whakamarama. There, on 29 April 1864, was fought a battle of special interest to military engineers. About 230 Ngaiterangi (and some Piri-Rakau) warriors armed with flint tower muskets, double and single barrelled shotguns and long-handled tomahawks defeated General Cameron's attacking force of nearly 2,000 men supported by fifteen artillery pieces. The attacking force suffered a loss of 111 killed and wounded, the Maoris about twenty-five killed. The Maoris, showing great military engineering skill, converted a grassy knoll into a defensive work that withstood the assault of the large and well supported attacking force. The land on either side sloped quickly to the swamps that run up from the tidal arms of Tauranga Harbour. The whole of the main works was enclosed by a single light fence lashed to two rails with flax, the interior being a network of traverses, covered ways and shelters cleverly covered over with a scanty supply of timber and blinded with flax and brushwood.



TAURANGA BUSH CAMPAIGN 1867

The Auckland Volunteer Engineer Company, formed under the authority of "The Volunteer Act 1865", in the early part of 1867 fought engagements with the Hauhau members of the Ngatiporou tribe, along the bush covered tableland to the rear of Tauranga. The Engineers formed part of a column of several companies of the 1st Waikato Militia and armed Arawa Maoris.
Being for the most part well equipped and suitably armed young surveyors, under the command of Captain H. L. Skeet, they had been sent to the area to survey confiscated lands
The Engineer company generally led the van, and were left to discover and dislodge the enemy. Private James Wooley was shot in the groin at Te Ake Ake and was defended from being tomahawked by Private G. T. Wilkinson and later Pte Tom Jordan was killed at Te Umu-o-Korongaehe close to Whakamarama. The routes followed and the sites of the skirmishes are marked on the map.

Figure 1

began on 15 February. The Government Force, under Lieut-Colonel Harrington, included Captain H. L. Skeet, Lieut W. J. Gundry and twenty-five other ranks of the Engineer Company including the original survey party recruited to survey the Katikati Block.

This expedition spent the first night in bivouac at Awangarara, on the Wairoa River and reached the Irihanga village on 15 February. The village, which stood on the eastern fringe of the forest, was strongly held. The Hauhaus held their fire until troops were in open ground near the summit of the hill on which the village stood, about 150 yds from the bush edge. Fern grew about 8–10 ft high and the Hauhaus had cleared a space between the hill and the bush proper by treading the fern down. Not only did this enable the defenders to fire destructive volleys, but also it impeded the attackers, as the fern was pressed over in the direction of the line of march.

However, the hill was captured by Major Mair's Arawas who drove the Hauhaus into the bush before they could reload after their first volley. The force then advanced towards Whakamarama, the headquarters settlement of the Piri-Rakau, where their main source of food was obtained from over 100 acres of maize and potatoes. The Hauhau pole of worship, a tall "niu", encircled by a red painted railing modelled on church altar rails, stood erect in the village; around it the Hauhau adherents had marched as they had chanted their incantations.

The retreating enemy were pursued through the forest belt which separated Irihanga from Whakamarama and elected to make a stand under cover of some large trees and logs. Fierce tree to tree fighting ensued but the Hauhau broke and fell back on their main body at Whakamarama village. Here skirmishing continued through the maize fields.

Forced back to the western edge of the clearing, the Hauhaus made a further stand at Te Umu-o-Korongaehe at the edge of the bush. Privates E. Goldsmith, A. Crapp and Tom Jordan of the Engineer Volunteers, together with personnel of the 1st Waikato Regiment, engaged a group of Hauhaus positioned behind a large tree lying across the track. The Hauhau here mortally wounded Tom Jordan, but an officer of the 1st Waikatos killed Raumati, a chief of the Piri-Rakau. Discouraged by their chief's death, the Hauhau withdrew. In this way New Zealand Engineers suffered their first fatal casualty in a skirmish in which most of the fighting for the Government was done by friendly Arawa.

This was the main skirmish of the campaign which was to end in early March. Having destroyed the huts in the group of villages about Irihanga and Whakamarama, the Government Force returned to Tauranga. Photo 1 shows the site of the skirmish at Irihanga, looking west towards Whakamarama.

The Commemorative Service—18 February 1967

Wishing to commemorate the centenary of the first active service engagement in some suitable manner, the Corps Committee considered various alternatives. With the concurrence of the Education Board, it was decided to erect a simple memorial cairn in the grounds of the Whakamarama Primary School which is adjacent to the battlefields of 1867. From the eminence on which the school stands amongst dairy farms, one may see much of the country over which the skirmishes took place. After some investigation, a block of rhyolite from a near-by quarry was chosen to form the memorial stone. This seemed to typify the ethos of the area and blended readily with the school buildings and gardens.

The ceremony was held in the school grounds on Saturday, 18 February 1967, a warm midsummer day, and took the following form. Firstly, a Guard from 1 Construction Squadron, Papakura, formed up and at 2.30 p.m. was inspected by the Chairman of the Tauranga County Council (Mr C. A. Moore) and the Colonel Commandant of the Corps of Royal New Zealand Engineers (Lieut-Colonel G. A. Lindell, DSO, OBE). Then the following message from the Governor-General of New Zealand, Brigadier Sir Bernard Ferguson, GCMG, GCVO, DSO, OBE, was read by the Chief Engineer to the assembly:—

Photo. 1. Site of the skirmish at Irihanga.

"I am very sad that other commitments make it impossible for me to celebrate with you in person the glorious hundred years of dedication of your Corps both in peace and war. Your contribution to New Zealand history has been epic and I know that Her Majesty would want me to wish you all well on her behalf as indeed I do myself."

The County Chairman then welcomed the Corps and referred to its past exploits. The Representative of the Tauranga Historical Society (Mr L. Adams) then traced the events leading to the rise of Hauhauism and described the campaign in some detail. The Colonel Commandant in reply recalled that the Corps had served in World Wars I and II in Europe and the Pacific, in Korea, Malaysia, South Vietnam, Thailand, and had been involved in other military and peaceful activities in many parts of the world. He concluded:—

"Our Corps is proud of its past and traditions and it is fitting indeed to commemorate this Anniversary on this historic ground in our own country where the military traditions of our Corps were first established. In honour of the Auckland Engineer Volunteer Corps and the Corps of Royal New Zealand Engineers, I now unveil this Memorial Cairn." (Photo 2.)

Chaplain H. Shaw then dedicated the memorial.

The bronze plaque secured to the rhyolite stone bears the following inscription:—

The Corps of Royal New Zealand Engineers

Early in 1867 a Company of Auckland Engineer Volunteers campaigned on the Hautere Plateau. This stone was laid on 18 February 1967 to commemorate the actions of 15 February 1867 at Te Irihanga and Whakamarama in which these New Zealand Engineer Volunteers took part.

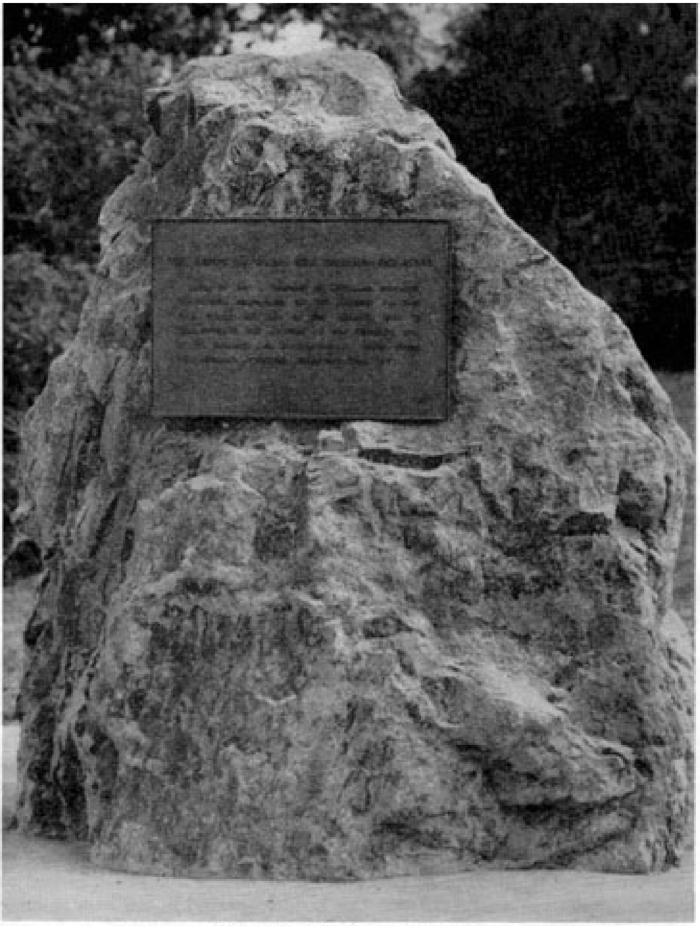


Photo. 2. The Memorial Cairn.

Epilogue

The deeds of these Engineers among the hills and valleys of Whakamarama form part of the legend of the Corps; this historic ground will be remembered not only as the birthplace of the Corps, but also as the birthplace of a tradition of close affiliation between New Zealand Engineers and Infantry that was to endure and be strengthened in two world wars. For the Maori and "Pakeha" members of 1 Construction Squadron RNZE who formed the Ceremonial Guard it held special significance; here they could pay their respects to the fighting men of both sides who fell during the Tauranga Campaign.

The French Engineer School, Angers

By Major A. G. T. Shave, MBE, RE

Plus mon Loyre Gaulois, que le Tibre Latin
Plus mon petit Lyré, que le mont Palatin
Et plus que l'air marin, la douceur Angevine.

Du Bellay-Sonnet, 1549

The Ecole d'Application du Genie traces its history from the Royal School of Engineers at Mezieres, 1748–94, and the Combined School of Engineers and Artillery located at Metz from 1802–70 and at Fontainbleau from 1871–1912.

In 1912 the Engineers broke away from the Artillery, and the Engineer School transferred to Versailles, where it remained until 1940; the Corps of Signals, having been developed by the Engineers, was then formed into a separate arm, and once again the Engineers moved, this time to Avignon. The occupation of the area by the Germans in 1942 resulted in the closure of the school, and it did not reopen again until November 1945, when it was installed at Angers in the old barracks of the Pontoon Section of the 6th Engineer Regiment. Happily, the Colours of the School were saved and remained hidden throughout the occupation; they now provide one of the few remaining links with the past.

The barracks, Caserne Eble, is named after the Engineer General responsible for the crossing of the Beresina River. Several of the buildings were badly damaged by air raids during the last war, and most of the others sadly needed modernizing when the School moved in. Classrooms, lecture halls, library and workshops, all were lacking and had to be constructed. Over the past twenty years all these tasks have been completed, and the School can now proudly claim to be one of the best equipped in France, with the added attraction of lawns and flowerbeds that would do justice to any English stately home, and which give it an air of distinction not normally found in French military establishments. The School is also rapidly building its own traditions, having lost so much from the past with the many moves.

Responsibilities

The School is responsible for the basic and continuation training of all officers and NCOs in the Corps of Engineers. Each year some 1,500 students attend courses varying in length from one to twelve months; bearing in mind that no courses are held for Sappers, this results in an average student population of 700 officers and NCOs throughout the year.

To cope with this total, an organization has been developed which clearly reflects the French penchant for logic, and which is consequently dissimilar from most British military schools.

The main course, somewhat naturally, is the Regular YO Course. Each year the second lieutenants who pass out from St Cyr-Coetquidan and have opted for the Engineers, numbering about thirty, together with those from the Ecole Militaire Interarmes and about twenty foreign student officers, form up in September and start their year's course. The average size of this 1st Division is about seventy-five, and the aim of their training is to make them into Engineer Troop Commanders.

The School is also responsible for training reserve officers; these, despite the name, are in fact National Service Officers completing their sixteen months' obligatory service. There are two groups of these; the 2nd Division, consisting of the student officers coming from the Polytechnic or other similar Institutions such as the Mines School, Bridges and Roads School, Forestry School, Rural Engineer School etc, for whom there is one course of four months a year; then the 3rd Division made up of three consecutive courses a year, each of four months, for the NS student officers who have completed a senior military preparatory course before being called up, or who have been selected in units after being called up. In the main these students have already received some training as engineers, and, unlike the 2nd Division, they are not commissioned until they have completed the course.

Finally, for officers, there is the "Division de Perfectionnement" which runs the upgrading courses. For regular officers there is a course of one month each year for twenty majors or young lieut-colonels being trained as commanders of divisional engineers; plus a second course of four months each year for recently promoted captains being trained as company commanders. (The French Engineer Company is always commanded by a captain.) In addition, one electrical or mechanical engineering course lasting six months is run each year for ten subalterns.

For NS officers who have completed their sixteen months service and rejoined the Reserve, four promotion courses, each of three weeks, are run each year. Three of these are for lieutenants, recommended for promotion to captain, and one for captains recommended for promotion to major.

Regular NCOs are also trained at the School; these have normally enlisted for three to five years and fall into two groups. Firstly the Eleves Sous-Officiers d'Active (ESOA) or 5th Division, who complete a one-year course to become engineer sergeants before being posted to a field unit for the first time; the current ESOA course is 150 strong. Secondly the Sous-Officiers Eleves (SOE) or 4th Division who have already completed a four month basic training course at the 6th Engineer Regiment, plus a six-month infantry type course at the "Ecole Nationale des SOE" at Saint-Maixent, and who then complete a four-month engineer course at the EAG; there are six intakes of SOE, commencing every two months during the year, and strengths have been as high as 150 a course, but have now dropped to around thirty-five. Thus this year the School will produce some 350–400 corporals and sergeants who will serve for the first time in companies and regiments, where the majority of the men are conscripts. Other courses for senior NCOs include the one-month course for the 2nd degree of "Brevet d'Arme" and the four- or six-months course for the engineer "Brevet de Specialite", 1st or 2nd degree. For the latter courses the candidates may choose to specialize in either plant operating, repair and maintenance of plant, electricity, resources and accounting, or topography, while the Brevet d'Arme, 2nd degree, is designed to complete the training of troop sergeants and make them into instructors.

The School is also responsible for the editing and printing of engineer pamphlets, manuals and precis for all courses at the School, plus a number of official and Corps publications which are distributed by the library to all Engineer units. These include, twice a year, a written exercise with a tactical setting on which a number of questions are posed for all majors and junior officers. Fortunately for the EAG, the correction and marking of these

Photo 1. Y.O. Colour Party with EAG Colours.

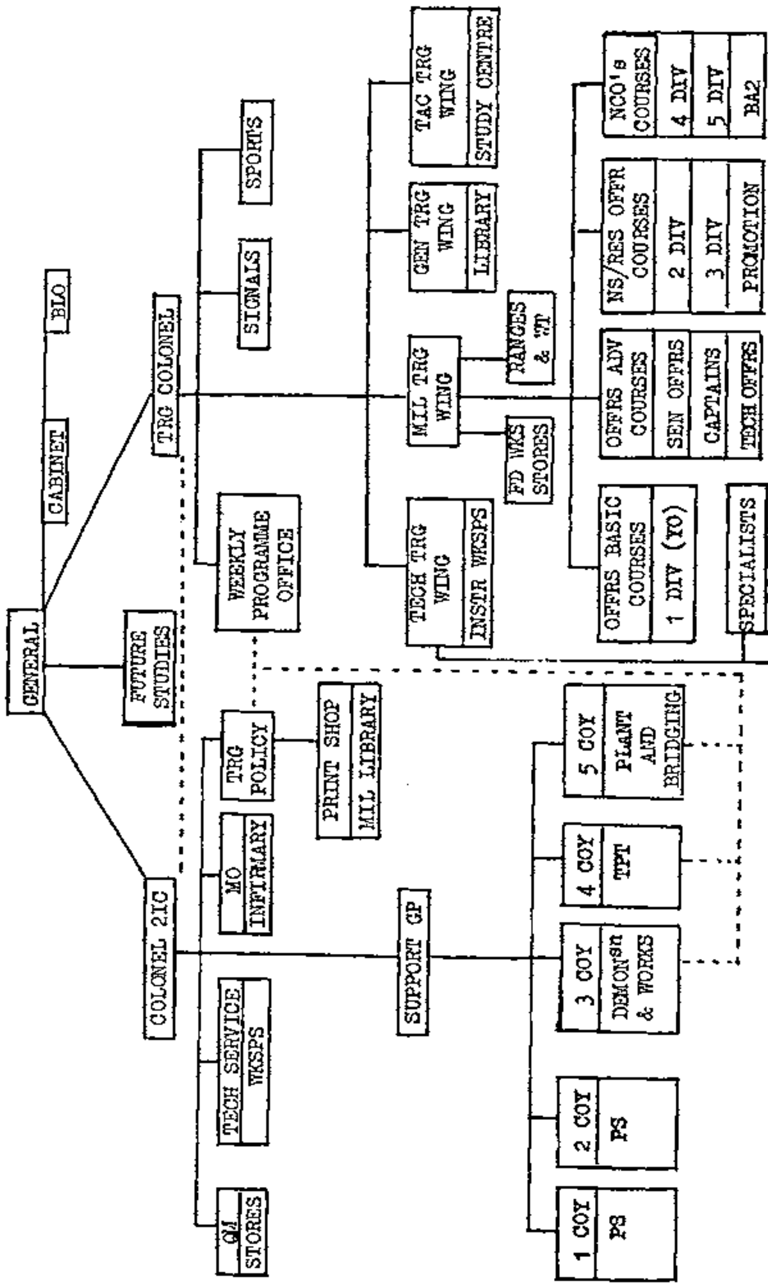
is delegated to the equivalent of the Chief Engineers Branch in Commands. Finally the School is charged with carrying out studies on the future organization and employment of engineers.

Organization and Training

As already mentioned, the organization which has been designed to deal with this load is most interesting, but space does not permit more than a brief description.

The Commandant is a Général de Division, equivalent to a major-general, but with three stars instead of the Anglo-Saxon two. He has a Colonel Second-in-Command, who shoulders all the administrative load, another Colonel responsible for all training, and a Chef de Cabinet with the rank of major who is responsible for all external non-military contacts with the press, public relations, local administration, liaison with the prefet, mayor and gendarmerie, and also for all social functions, receptions, dinners, visits and

EAG ORGANISATION



veterans reunions. The future studies team of two lieutenant-colonels also works directly under the general.

The Colonel, Second-in-Command, is responsible for the support group of five companies, two for administrative staff, one for maintenance and operating staff, one transport company and one plant and bridging company. There are no regiments as such supporting the School, and the whole of this group is commanded by a major, with a captain for each company. The Second-in-Command is also responsible for the QM, with his very considerable accounting load which is worked on a credit and local purchase basis, the technical services, and the training policy office which controls the over-all school loading and puts the MOD policy into effect. This latter office in turn controls the military library and the printing shop, with its three offset and two typographic presses and photographic section.

The administrative problems are much the same as those met in any similar British school, with the exception possibly of the Officers' Mess. This is run more on the lines of a club than a British mess, and families may use its facilities at all times. Guest nights or dinner nights do not exist as such, and official entertaining in the Mess is normally limited to lunch time.

The training side is more complex; the Training Colonel is firstly responsible for the five student divisions, co-ordinated under the Military Training Wing. Each division again has its own staff of Captain and Lieutenant instructors, and they are grouped for command purposes with a major in charge of the 1st Division (Regular), another responsible for the Reserve 2nd and 3rd Divisions and the third commanding the Sous-Officers 4th and 5th Divisions. The commanders of the student divisions administer their own students, and are responsible for much of the day to day training which does not fall directly on the separate wings.

In addition to the Military Training Wing, the Training Colonel controls three other wings or departments:—

Military Training Wing. Responsible for all military field training, including ranges of all types, anti-tank course, weapon training and general supervision of external exercises, and co-ordination of student divisions.

Technical Training Wing. Divided into five main groups, Plant, Electrical, Mechanical, Civil and Topography, each with its own workshops and a major in command of each group.

General Training Wing. Current affairs and culture, non-military library, methods of instruction and languages.

Tactical Training Wing. All engineer and all-arms tactical training conducted in classrooms plus the tactical setting of external exercises. The cavalry, infantry, artillery and AAC each provide one officer instructor.

These wings are normally commanded by lieut-colonels, each with his own instructional staff.

The Training Colonel is also responsible for the Signals department, commanded by a Signals captain, the Sports department and the weekly programming office. This latter co-ordinates all courses and training in the School, allocates training areas, classrooms, equipment, plant and vehicles as necessary, and is in fact the nerve centre of the organization, working several weeks ahead. Since all the divisions are divided into brigades or platoons, and receive instruction on this basis, the programming office has to cope with between twenty-six and thirty different groups of students each day. Although there is no helicopter flight at the EAG, the School has call on

Photo. 2. The EAG, Caserne Eble.

The French Engineer School, Angers 2

the flight at the Cavalry School at Saumur, as well as those at Rennes and Tours; several of the demolition and raid type exercises depend upon helicopter lifts using the larger Vertol H21 (banana) while Djinns or Alouettes are usually available for recce purposes, either for staff or students.

The most interesting element to an outsider is the General Training Wing. This consists of a lieut-colonel, major, four captains/lieutenants and about ten "professors" who are NS sappers, chosen for their intelligence and capabilities as instructors; most of these professors have already obtained or are studying for a degree, and though they only draw the normal ninepence a day pay of a conscript, they enjoy a privileged position and wear civilian clothes instead of uniform. They teach a wide variety of general educational subjects, including history, geography and cultural subjects, as well as languages (English, American, German and Spanish). Language training is obligatory for all regular YOs, usually 1 hr per week, but there are also voluntary classes twice a week from 1800–1900 hrs, and currently some forty-odd members of the permanent staff attend these courses regularly. The School is well equipped with a language laboratory of ten tape recording cabins and a master control unit. It should also be explained that the standard working day is 0800–1800 hrs, with 2 hrs for lunch, no games afternoons on Wednesday and normal working on Saturday mornings from 0800–1200. Needless to say that the YOs envy the more liberal hours of their opposite numbers in Chatham!

Recreational activities are strongly encouraged, but must normally be fitted into the daily programmes; thus competitive team sports are not always possible, and to fit in with the accent on commando type endurance training much of the recreation consists of 5, 10 and 15 Km forced marches. As an example, the reserve or NS officers have a standard "rally" in their last month, in which they move independently at commando pace over four different routes at 5 min intervals, and cover 25 Km split by six test points, where they are required to pass tests on bridging, signals, mines and demolitions, grenade throwing and firing on the full bore range. The first officer in on the current course completed this rally in 3 hrs 15 min, of which about fifteen minutes was spent in the test areas. The NCOs have to complete a similar rally, but of 100 Km, including an assault crossing, over a period of 48 hrs.

Because of the system of grouping for training by brigades or platoons, allocation of training areas presents quite a problem; however, in this respect the School is most fortunate. In addition to the Caserne Eble there are two bridging schools, one on the Maine with excellent hard facilities, the second on the Loire where there is a much stronger current which makes it ideal for advanced training. Both have some 300–400 yds of hard facilities and are equipped with M4T6, M2 and Gillois equipment plus the usual range of watermanship equipment. Considerable emphasis is placed on watermanship training, but paddles replace oars in the French Engineers, rafting and bridging operations almost invariably use motor tugs for propulsion, and outboard motors in the form of 25 hp Johnsons, are normally only used for assault boats and safety boats.

The third training area, close to the School, contains the plant training area, a dry gap for Bailey, M4 and timber bridging, the latter still remaining as one of the subjects in which the French Engineers take considerable pride. There is also a helicopter pad, pistol range and "ballplast" range, on which full-bore ammunition with a plastic bullet is fired up to 100 yds range for grouping and zeroing practise, without requiring all the usual safety precautions connected with full-bore ranges.

The School has also recently taken over the Forest of Linieres, some 320 acres of wooded area, which has now been developed into a training ground with a demolition area, an anti-tank course, mine warfare area and a troop commander's track suitable for deploying and handling a troop in the various phases of combat with very realistic problems built in.

In general, it is noticeable that the EAG spends considerably more time on all-arms training than we do. The officers receive, in addition, a fairly comprehensive cultural background; this year, for example, the YOs were split into groups to study respectively such subjects as the medical system, journalism, law and local government, local agriculture, marketing and social life etc; 14 hrs were allocated for this part, and then each group of students was required to present its findings to the whole class and to answer questions in a series of study periods. Only a very small proportion of officers follow the equivalent of a degree course, which is perhaps to their eventual benefit, as officer's pensions in the French Army, which can rise to a maximum of 80 per cent of their basic pay prior to retirement, are conditioned not only by total years of service, but also by the period spent in operations or under arduous conditions; one year spent in Vietnam for example, counted as three years service towards pension, and in Algeria two years service towards pension.

Before concluding, some mention must be made of the local countryside; within daily striking distance of the School one can find practically every type of wet and dry gap, every type of bridge construction for demolitions, and most types of ground for tactical exercises. A simple liaison visit to the local farmer, a week or so before the exercise, is all that is necessary for the commander of the training division concerned to be given almost free ranging rights over the land required; should any gates be left open after the exercise, or any damage caused, this is invariably sorted out between the owner and the School with the minimum of fuss. On many of these exercises, conducted near some small village, the local mayor will afterwards offer a "Vin d'honneur" to the students and staff, at which the local dignitaries give the wine and welcome the School, whereupon the senior officer makes his small speech of thanks and all then depart with an air mellowed by good wine and cordial relations. With the mild weather, pleasant Anjou country and friendly population, the EAG is indeed fortunate to live amidst "La douceur Angevine".

Photo. 3. The Bridging School on the River Maine. New sports ground and helicopter pad in centre foreground, dry bridging area in front of railway and EAG in left background.

The French Engineer School, Angers 3

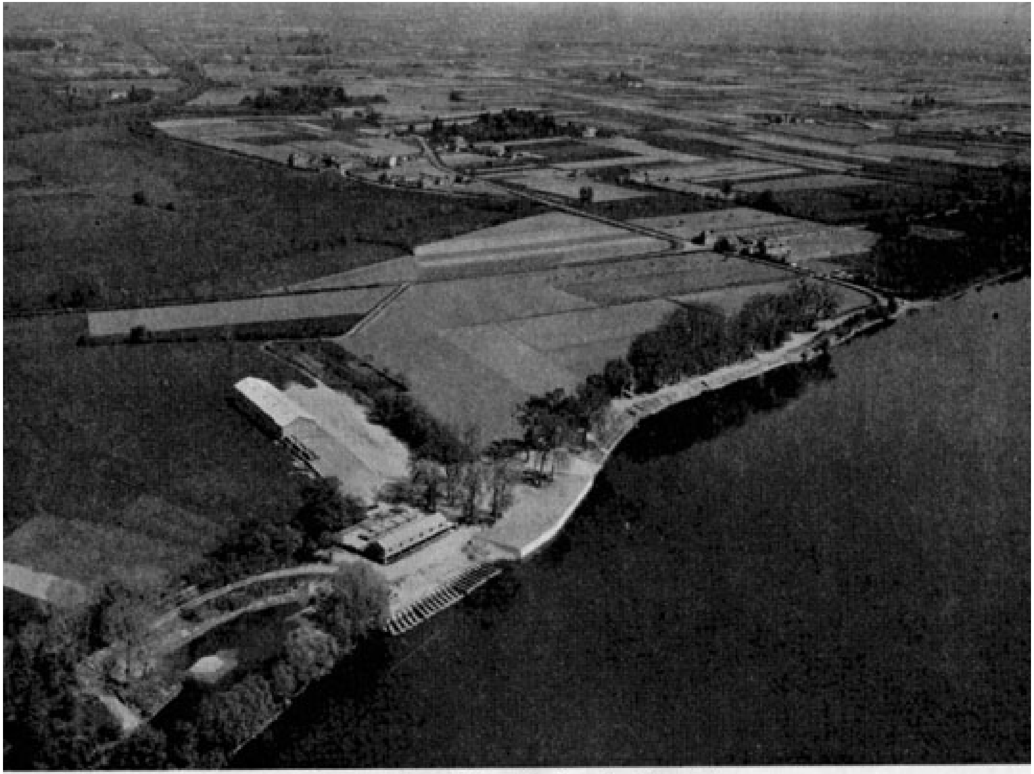


Photo. 4. The Bridging School on the River Loire.

The French Engineer School, Angers 4

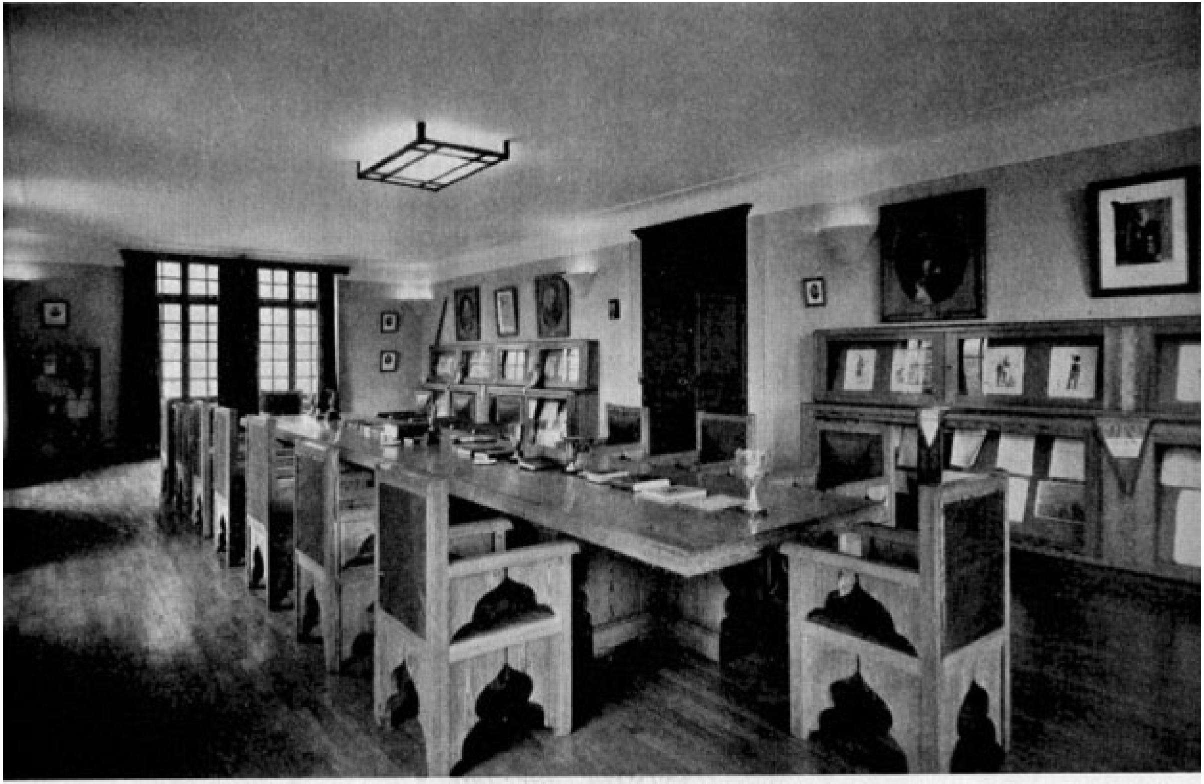


Photo. 5. The "Salle d'Honneur".

The French Engineer School, Angers 5

Photo. 6. Junior Officers' Dining-room in the Mess.

The French Engineer School, Angers 6

Memoirs

DOCTOR J. DE GRAAFF-HUNTER, CIE, MA, ScD, FRS

James de Graaff-Hunter CIE, MA, ScD, FRS died at Mosman, New South Wales, on 3 February 1967 at the age of 85. He was elected an Honorary Member of the Institution of Royal Engineers in 1920, and was well known to surveyors for his geodetic work in the Survey of India and the International Association of Geodesy.

Dr de Graaff-Hunter was educated at King's School, Chester, and at Pembroke College, Cambridge, where he took First Class Honours both in Mathematics in 1903 (12th Wrangler) and in Mechanical Sciences in 1904. For a year he worked as Scientific Assistant to Lord Kelvin, and his connexion with surveying and geodesy began when he was appointed as Mathematical Adviser to the Survey of India in 1907.

His first scientific work in India was mostly concerned with atmospheric refraction and with the adjustment and analysis of large triangulation systems, but this work was interrupted by two years military service, in the rank of captain, with Survey in Mesopotamia and Western Persia.

After the war his interest turned especially to the determination of the form of the geoid by means of astronomical observations, but he was concerned with all the department's geodetic problems, and with many others, such as the production of the "Hunter short base" for use in rapid triangulation and traverse. In 1928 he was appointed Director of the Geodetic Branch, but to the great loss of the department he had to retire in 1932. He received the CIE in 1933.

During his first retirement he continued his geodetic work, and was elected a Fellow of the Royal Society in 1935. In 1941 he was in California, whence he sailed to rejoin the Survey of India. His ship, however, was intercepted in the Atlantic and he was taken to Germany with his wife and daughter, and held as a prisoner of war. Fortunately, after eighteen months they were allowed to proceed to India where he served until 1946.

During his second retirement his interest was mostly in the reduction of gravity observations and their use in determining the irregularities of the geoid. He was also, as he always had been, much interested in the affairs of the International Association of Geodesy, of which he was President in 1954–7.

Dr de Graaff-Hunter was an Honorary Member of the Royal Institution of Chartered Surveyors, and was a Fellow of the Institute of Physics.

In 1962 he moved to Australia, where he maintained his interest in geodesy until the last few months. In Australia he leaves a widow, a daughter, and three grandchildren. His colleagues have lost a wise and always cheerful friend.

G.B.

Dr J de Graaff-Hunter, CIE, MA ScD, FRS

COLONEL W. C. O. PHIBBS, OBE, BA

THE death of Otto Phibbs has reminded me of a very delightful companion and very able staff officer and I would like to pay a tribute to his memory. He was SOREI on the staff of the Chief Engineer Second Army from the formation of the Army Headquarters in 1943 until the final defeat of Germany. Throughout this time he carried the Chief Engineer's staff work on his shoulders, kept everyone in good heart and established conditions of mutual confidence with all the other branches of the staff of Army Headquarters. As Chief Engineer during the first part of his time at Second Army I can express my personal feelings of gratitude to one who was utterly reliable and always good humoured and a real source of confidence to every one who worked with him.

J.S.W.S.

Book Reviews

GALLIPOLI—THE FADING VISION

By JOHN NORTH

(Published by Faber & Faber. Price 9*s* 6*d* net)

At 0622 hrs on 25 April, fifty years ago the *River Clyde* grounded at Sedd-el-Bahr and officers and men of the 29th Division vainly strove to struggle ashore through a hail of bullets. Thus began a classic military failure that was to cost a quarter of a million British and Commonwealth and French casualties. Side by side with the "white" English, Scottish, Irish and Welsh and Australian and New Zealand soldiers fought Sikhs, Punjabis, Gurkhas and Maoris, and with the French Army Algerians, Zouaves, Goumiers, Senegalese and various elements of the Foreign Legion. Against them stood the German-directed "Johnnie" Turk who proved himself as gallant a foe as ever faced British arms. Outstanding among them was Mustafa Kemal—then a Divisional Commander—who was to become the founder of modern Turkey. The Australian official historian of the time described him as "the greatest leader on the Eastern front"; the British official history of the campaign presented a more prophetic comment: "Seldom in history can the exertions of a single divisional commander have exercised so profound an influence, not only on the course of a battle, but perhaps on the fate of the campaign and even on the destiny of a nation".

But it was not only Johnnie Turk that our soldiers had to fight. There were other foes, namely a lack of water and dysentry. The majority of the men in the Gallipoli front line would in France have been on the sick list. And above all there were the flies feeding in their thousands on the unburied dead, a plague hardly less intolerable than the debilitating scourge of dysentry itself. There was no hope of a Blighty wound, the most distant medical evacuation from Gallipoli was to Alexandria or to Malta. The ravines and the cliffs and beaches of the Peinsula afforded no respite nor rest camp for the haggard fighting man, engaged in what many considered to be no more than a "side-show" to the Western Front. The administrative backing of the force was as slim as that provided sixty years earlier for our troops investing Sebastopol.

The author has described most graphically this story of human sacrifice and suffering, and in its wider aspect he has shown how this "sound and far-sighted conception, marred by a chain of errors in execution almost unrivalled even in British history" dovetailed into the often-conflicting overall plans for winning the war, or avoiding losing it.

THE ART OF COUNTER-REVOLUTIONARY WAR

By JOHN L. MCCUEN

(Published by Messrs Faber & Faber. Price 42*s*)

For the past twenty years we have been living in an era of revolutionary wars. Greece, Malaya, Algeria, Kenya, Cyprus, The Congo, Yemen, Cuba and Indo China are but some of the countries which have experienced or are still experiencing them. Whether we like it or not, there seems as yet no visible end to this type of warfare. Too often, however, in recent years, the "know-how" for combatting revolutionaries, so painfully acquired, is often frustratingly allowed to fade at the end of a campaign; or worse, to be remembered only in forms of aphorisms and clichés seldom applicable to the new situation.

This book is the first comprehensive study of the techniques of revolutionary war and, by deduction, of the most effective ways of countering and combatting it by, psychological and political, as well as by military means. The author, Lieut-Colonel McCuen, is a serving officer in the United States Army. His book contains studies of a large number of recent examples of the various phases of revolutionary warfare and the ways, both successful and unsuccessful, efforts have been made to counter them. As a result, he has drawn certain deductions and established certain basic principles for the successful execution of counter-revolutionary warfare.

His book sadly relates how, in the past, the initiative has almost invariably been left with the revolutionaries too long, primarily because of political weaknesses, but basically, also, because of poor intelligence and too little or wrong psychological, political and military counter-action, too late.

Lieut-Colonel McCuen rightly stresses the words of Field Marshal Sir Gerald Templer, when he was in complete charge of both Malaya and the Malayan counter-revolutionary operations, that "Any idea that the business of normal Civil Government and the business of the emergency are two separate entities must be killed for good and all. The two activities are completely and utterly inter-related." Politicians, Civil Administrators, Police and authorities in charge of Intelligence should heed his words every bit as much as officers in the fighting services.

Over and over again the reader is logically reminded about the basic necessities of counter-revolutionary warfare, namely the methodical establishment or, sadly, all too often the re-establishment of the initiative and of control over the country and its people by the very same techniques, but almost in the reverse order, as those adopted by the revolutionaries themselves; the establishment of firm military, then civil and political, bases, followed up by their expansion throughout the country; through territorial operations, counter-organization—including the organization of a "counter-purpose" for the people of the country—forbidden zones, ever improving intelligence with improving morale, mobile counter-guerilla operations, sealing off frontiers and so forth.

His bibliographies at the end of each chapter include valuable summaries of the most important contributions from each of the many books of reference.

Counter-Revolutionary Warfare is, however, a most variable and difficult type of warfare to learn about and in which to maintain strategic, leave alone tactical, initiative. In spite of the excellent principles and techniques expounded by the author, he is the first to admit that there can be no rigidity of action or counter-action.

This is probably one of the most important and valuable books on modern warfare yet to be published. It should be read by all politicians, policemen and other civil administrators, as well as by all officers in the fighting services who treat their careers seriously.

E.C.W.M.

AN INTRODUCTION TO HEAT TRANSFER PRINCIPLES AND CALCULATIONS

By A. J. Ede

Professor of Mechanical Engineering, University of Aston in Birmingham

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 63*s*)

This book is Volume 2 in the International Series of Monographs on Heating, Ventilation and Refrigeration published by Pergamon Press.

The text is very suitable for the Higher National Certificate student who does not wish to specialize and for whom a good general knowledge of the subject is sufficient. It therefore presents the theory underlying the subject, provides the principle results and formulae, and defines the techniques for obtaining solutions to calculation problems. It does not include a mass of numerical data, nor many charts, tables and curves illustrating the characteristic properties of various materials.

The standard of mathematics employed is largely confined to the use of GCE "A" level arithmetic and algebra.

After a general introduction to the principles and definitions of heat transfer, the chapters deal in succession and fair detail with: Radiation: Conduction: Convection (general, forced and free): Problems involving more than one mode of heat transfer: Boiling and Condensing: Heat exchangers: Mass transfer: The Air-Water Vapour system: Physical properties and other information.

A section is devoted to the use and conversion of the various systems of units employed for measurement and calculation, ie International units: cgs units and English metric units.

F.T.S.

C3: SQUARES, SQUARE ROOTS AND PRODUCTS OF NUMBERS

By C. Attwood

Principal, Apprentice Training, Ford Motor Co Ltd

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 27*s* 6*d*)

This is a combined edition of the author's *Practical Table Series* Nos 6 and 7 which gives the squares, square roots and products of numbers in one book.

The range covers: Squares 1.000 to 10.000; Square roots 1.000 to 10.000 and 10.0 to 100.00 to seven figures; Square roots and Reciprocal Square roots from 1 to 100; Products of numbers from 1 to 999 by numbers from 1 to 100.

Included are comprehensive notes on the way to use the tables.

Those interested in the origins of these kinds of modern mathematical tables will find the nine-page reproductions of earlier (1532–1820) tables of historical value. The reproduction of the title page of John Paul Büchner's *Tabula radicum* . . . 1701 . . ., which is used as a frontispiece to this book, is quite extraordinary. This depicts a workman of the period using a lever on a large rectangular stone which may, perhaps, be analogous to the use of the tables, but the inclusion of Cupid weighing the virtues of Büchner's book against a stone cube of known size suggests that the little chap was neglecting his duty in 1701.

F.T.S.

FLUID MECHANICS, THERMODYNAMICS OF TURBO MACHINERY

By S. L. Dixon, BEng, AMIMechE

Lecturer in Mechanical Engineering, University of Liverpool

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 25*s*)

The text of this soft-covered book examines, through the laws of fluid mechanics and thermodynamics, the means by which the energy transfer is achieved in the chief types of enclosed turbomachines such as centrifugal pumps, fans, compressors, axial and radial flow turbines.

An introductory chapter covers definitions, units and dimensions, dimensional analysis, performance laws and characteristics, speeds, cavitation and compressible fluid analysis. Later chapters also contain references to actuator disc theory and the phenomena of surge and rotating stall found in compressors.

Each chapter end is provided with a number of past examination questions (with answers) of the University of Liverpool.

In effect the text follows a course of lectures given by the author at the University of Liverpool and is, therefore, most suitable for undergraduates or engineering students taking courses leading to an Honour Degree in Engineering Science, a Diploma in Technology, or other qualifications of equal standing.

The descriptive text is cut to an understandable minimum and illustrated by well-drawn diagrams and sketches.

F.T.S.

COMPOUND INTEREST FUNCTIONS

By C. Attwood

Principal, Apprentice Training, Ford Motor Company Ltd

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 17*s* 6*d*)

This compilation is No 8 in the author's *Practical Tables Series* of which No 1–7 inclusive have already been reviewed in the *RE Journal.*

For those interested or engaged in the arithmetical problems concerned with loans, annuities, mortgages, leases and many forms of investment, who are not blessed with the use of a digital computer or any great knowledge of these matters, will find these tables and their associated notes of considerable service.

Included are:—

Compound interest functions
$\frac{1}{16}$ per cent to $2\frac{7}{16}$ per cent at interval of $\frac{1}{16}$ per cent.
$2\frac{1}{2}$ per cent to $4\frac{7}{8}$ per cent at interval of $\frac{1}{8}$ per cent.
5 per cent to 10 per cent at interval of $\frac{1}{4}$ per cent.
$i/i^{(p)}$ and Force of Interest δ from $\frac{1}{16}$ to 10.

The notes on compound interest which are given at the end of the tables give definitions of interest and its variations; worked examples of calculated compound interest, present value and compound discount, the use of tables $(1+i)^n$ and $(1+i)^{-n}$, fractional interest periods in twelfths, relation between effective and nominal rates of interest, continuous conversion of interest, force of interest, linear interpolation; and the definition, symbols and calculation of annuities, sinking funds, amortization and the like.

The whole book is obviously a godsend to the man from the Prudential and those who want to really know what he is talking about.

F.T.S.

CONCRETE MIX DESIGN (SECOND EDITION)

By J. D. McIntosh MSc, AMICE, AMIStructE

(Published by the Cement and Concrete Association, 52 Grosvenor Gardens, London SW1. Price 40*s*)

The second edition of this book was published in 1966 and therefore includes the amendments made necessary by the publication, early in 1965, of a new code of practice for the Structural Use of Precast Concrete (CP 116) and the first amendment to the code of practice for the Structural Use of Reinforced Concrete (CP 114). These new and revised codes of practice made four radical changes in the approach to concrete mix design. The first is the introduction of standard mixes, based on constituent proportions by weight and designated by the works cube strength at twenty-eight days. Standard mixes replace the nominal mixes used previously and based on volume proportions. The second is the introduction of more comprehensive requirements for the durability of concrete and for the amount of cover to reinforcing steel to provide adequate protection under various conditions of exposure. The third change is the introduction of a statistical control technique for conditions of continuous production of concrete such that failure to comply with the requirement results in the rejection of the mix proportions rather than the concrete itself. Lastly the elimination of stringent strength requirements of preliminary test cubes and the general adoption of the standard deviation of cube results as the measure to be used for assessing the variability of concrete produced from a particular plant. It includes a brief survey of the more academic approach to mix design by making reference to the recent work of research investigations aimed at achieving precision by having a more detailed knowledge of the properties of aggregates.

This book is a very comprehensive study of concrete mix design and contains a number of very useful graphs and tables from which concrete can be designed for any purpose. The approach to mix design is similar to that given in Road Note No. 4—The Design of Concrete Mixes published by the Department of Scientific and Industrial Research which is generally considered the standard reference on this subject. Mr McIntoshs' book is well written in logical sequence, is very easy to understand and is probably the best reference book on the subject for an RE Officer or Clerk of Works.

In addition to his book, the Cement and Concrete Association also publish a pamphlet by Mr McIntosh which contains all the tables, graphs and design data from the second edition of his book. The cost of this pamphlet is 20s. It would be very useful to the engineer who needs the data for design purposes but does not need the detailed explanations given in the book. R.C.G.

Technical Notes

CIVIL ENGINEERING

Notes from *Civil Engineering and Public Works Review*, January 1967

"Notes of the Month" in this edition report that there is an increasing requirement for British Consulting Engineers to be able to compete on a fair basis with their foreign counterparts in obtaining work outside the United Kingdom. At present bound by stringent rules of professional conduct, incorrectly considered in certain quarters as restrictive practices, the consultant will find when operating in an overseas market competition and professional practices run on vastly different lines from those in this country; he may even encounter government subsidized fees and quasi-commercial operation with local embassies very much to the fore in getting their own country's consultants appointed.

Also reported is the formation of the first of six Road Construction Units by the Ministry of Transport which will be responsible for the design and supervision of all major roadworks within their areas. This item at first sight may appear unrelated to the aforementioned item. However, when one considers that this is hardly likely to improve the opportunities of the consultant obtaining work at home, the connexion is apparent. This combination of unfair competition abroad and governmental constraint at home must lead to some changes within the profession as a whole. Whatever these changes may be it is to be hoped that professional integrity will not be in any way subordinated to commercial or political pressures. It is interesting to note that the Ministry of Transport has developed an amended design for motorways which reduces the cost per mile by decreasing the construction width. It is presumed that the same consideration was given to any reduction in the standards of safety as would be given by a consulting engineer when considering the possible results of a reduction of the load factor in the design of a building for his client.

ANCHORAGE ZONE REINFORCEMENT FOR POST TENSIONED CONCRETE. This interesting article by D. J. Dowrick, BE, AMICE, a senior engineer on the staff of Messrs. Ove Arup & Partners presents a design office method for reinforcing prestressed concrete end blocks, adding some useful design cases and indicating where stresses may be modified in the ultimate case. Included are four graphs showing design conditions for the area of steel required at loads in the tendons of 70, 77, 85 and 100 per cent of the ultimate tensile strength, the first and last mentioned graphs being those used in the more normal design cases following CP 115.

The paper also gives a method of determining the position of the required reinforcement and concludes by giving some practical guidance for the selection of minimum amounts of reinforcement in cases where the previously described method indicate that theoretically none is required.

THE TUNNELLING ENGINEER. Part 1 of this excellent and very readable article by D. A. Harris BSc, MICE, Chief Engineer and a Director of The Mitchell Construction Co Ltd, deals with the world of the "tigers", or rock tunnelling. Part II describing soft tunnelling is to follow in the February edition.

The author follows the history of rock tunnelling and cites the Frejus tunnel in the Alps to outline the difficulties incurred when all rock drilling had to be carried out by hand. If Sommeiller had not invented the mechanical rock drill during the construction of this tunnel it is doubtful if the task would ever have been completed. Indeed after eleven years of the total fourteen taken in its construction consideration was still being given to the project's abandonment.

Although improvements were made to Sommeillers drill during the following years there was no real technological jump forward until nearly one hundred years later with the invention of the tungsten carbide tip for the steel drill, which enabled the tip life to be increased, from 3 ft between sharpenings to 70 ft.

The article compares the Swedish method of drilling using a light rig with the much heavier machine known as the drifter favoured by the Americans which has given rise to the term The American Method. The recent tunnel at Mont Blanc has enabled the author to draw an interesting comparison between these two methods as the French side of the tunnel was driven using a drifter while the light Swedish drill was favoured on the Italian side.

Of the other main tasks involved in hard rock tunnelling, mucking and blasting, some useful information is given to help in the choice of mucking equipment for various sizes of tunnel while a general description is given of the principles involved in firing a face.

Moving on into the twilight zone of tunnelling in unstable rock the author begins to discuss the problems associated with this, perhaps the most difficult type of driving. However, having wetted our appetite we must wait for the February edition to complete reading this very worthwhile article.

FATIGUE TESTS OF LARGE DIAMETER DEFORMED HARD DRAWN WIRE USED FOR PRESTRESSED CONCRETE. This paper has been written as a result of fatigue tests carried out by E. W. Bennet, MSc, PhD, AMICE, AMIStructE, and R. K. Boga, MSc, BE (Civil) in the Department of Civil Engineering of Leeds University under the general direction of Professor R. H. Evans, DSc, DesSC, MICE, MIStructE.

Hard drawn steel wires are widely used in prestressed concrete on account of their high strength and consequent ability to accommodate the inelastic strain associated with the compressive prestress in the concrete. The practical advantages of using wire of as large a diameter as possible is partly offset by the reduced bond strength and to overcome this disadvantage the wire is sometimes deformed, either by surface indentation or by crimping. However, from general experience of metal fatigue this treatment may well cause some reduction of the fatigue strength of the wire, and the tests recorded in this article were carried out to give an indication of this loss of strength in the largest diameter of hard drawn wire in general use for the pretensioning process.

The authors tests indicated that the fatigue strength of this wire (0.276 in diameter) is slightly reduced by indentation and to a greater extent by crimping. A conclusion in agreement with other work on this subject using the smaller diameters of wire. However, within the range of maximum and minimum stresses occuring within the normal prestressed structural member the tests show that none of the wires could fail through fatigue under normal service conditions.

NEGOTIATED SLIPFORM CONTRACT AT TUXFORD. SLIP FORM PAVERS have been used in America since 1949 and in Europe from the early 1960s. Their first use in England was for the A1 Trunk Road Improvement scheme's Cromwell By-Pass in Nottinghamshire in 1964–5. Since the contractors for that scheme, Robert McGregor and Sons Ltd, had purchased outright the Guntert and Zimmerman slipform paver, they were invited to carry out similar work for the Nottinghamshire County Council in the construction of the Tuxford By-Pass on a negotiated tender basis.

A short article describes the work being carried out on this contract which has now been running for fourteen months and is due to be completed in the spring of 1967. Of particular interest are the financial arrangements given in this article, but for those more concerned with the details of the engineering tasks involved in the use of slipform pavers the reader is recommended to read the comprehensive paper by Burks and Maggs in the February 1967 Proceedings of the Institution of Civil Engineers.

HYDRAULICS. For the more academic reader there are two articles, one describing the use of the Suspended Sphere Current Meter for use in the hydraulics Laboratory while the second evaluates a correction for the Prandtl-type Pitot-static Tube in pressure gradient flows.

B.O.B.

THE MILITARY ENGINEER

JANUARY–FEBRUARY 1967

NORAD COC. LESSONS AND PROBLEMS by Colonel Harold J. St. Clair, Corps of Engineers. The North American Air Defense Command Combat Operations Center (NORAD COC) inside Cheyenne Mountain near Colorado Springs is built to withstand intense effects of a nuclear explosion, and constitutes a vital part of the defense system of the United States. In this short, well illustrated article there is a great deal of information about the layout of the workings, the design of the buildings to withstand shock, and protection against blast and CBR (Chemical, Bacteriological, and Radiological) contamination. In addition there is much detail of tunnelling methods used. There are notes on the Works Organization for carrying out the project.

MASSACHUSETTS HURRICANE BARRIER by Colonel Remi O. Renier, Corps of Engineers. A description illustrated with photographs and maps of the works which have been carried out in the New Bedford area on the south-east shore of Massachusetts to protect a large area from the danger of floods which, in the past, have resulted from hurricanes. Briefly the project consists of a harbour barrier and dike containing a 150 ft gated navigation passage across the main harbour entrance, and smaller dikes elsewhere. Details of construction are given, particularly of the gates, including an account of their operation.

WORLD-WIDE GEODETIC NETWORK BY SATELLITE, by Rear Admiral James C. Tison Jr, Director US Coast and Geodetic Survey. The United States opened a new era in geodesy with the launching on 23 June 1966 of geodetic satellite Pageos 1 (Passive Geodetic Orbiting Satellite). This satellite, orbiting at an altitude of about 2,300 nautical miles above the earth, serves as a high-altitude beacon for geodetic observations. Simultaneous observations from widely separated ground stations will, for the first time, make it possible to determine the directions and lengths of lines up to 2,500 miles or more on the earth's surface with great accuracy and thus to span oceans, to connect continents, and to establish a basic world wide network or reference system. This article is an account of the design and construction of the satellite itself, with good illustrations, and a description of the triangulation procedures.

PORT CONSTRUCTION IN VIETNAM by 1st Lieut David P. Yens and Captain John P. Clement, III Corps of Engineers. Port facilities in Vietnam have had to be greatly extended to meet the needs of the American forces. This article describes in considerable detail the work that has been carried out by the Corps of Engineers. There are details of the DeLong pier which has been extensively used. It is essentially a 90 by 300 ft barge supported by eighteen tubular steel caissons 6 ft in diameter and 50 ft long. Caissons are joined end to end to provide the required length. These caissons are placed in collars attached to the pier and are driven into the harbour bottom by pneumatic jacks that are part of the collar. In this way the pier is jacked up on its legs to the desired elevation. The piers are towed out from the east coast of the US Port construction at Cam Ranh Bay, Qui Nhon and Saigon is described in detail and landing facilities at other places are referred to. The scale of the administrative backing to the Vietnam war is most impressive as has been brought out by several recent articles in the *Military Engineer*.

SULPHUR-AGGREGATE CONCRETE by Captain Roy A. J. Frusti, United States Air Force. A description of a study of the feasibility of using sulphur with sand and coarse aggregate as a structural material. The study established the proper proportions and the physical properties of sulphur aggregate mixtures. These are given in tables in the article. The results indicate that sulphur-aggregate concrete has a great potential as a constructive material primarily because of equal comparative cost, quick setting properties, and high early setting characteristics. However, not all physical and mechanical properties have been established and additional work is necessary.

FDL—"TOTAL PACKAGE" APPROACH TO A SHIP SYSTEM by Lieut-Comdr Richard L. Madouse, US Navy. FDL stands for Fast Deployment Logistic Ships. The article provides a description of the need for such ships to meet the requirement of the Forces in the future and the special means being taken to provide them. The essential point being that design is being left to civil firms in competition and a contract for an entire class of identical ships is on offer. This will make it worth while equipping the yard with production belt capacity and may make the US able to compete with the more up-to-date European and Japanese firms. The way in which the tenders are being called for and prepared is described and is most interesting.

BANGKOK BYPASS ROAD EXTENSION by Lieut-Colonel George A. Bicher, Corps of Engineers. A short interesting article which shews the extent to which the US are developing the road system in Thailand.

SOILS ENGINEERING PROBLEMS. BANGKOK BYPASS ROAD EXTENSION by Lieut James E. Kellet Jr, Corps of Engineers. A brief description of the problems met with on a section of the above road where suitable material could not be found.

SPECIAL ACTION FORCE IN LATIN AMERICA by Major Harry C. Hoffman III, Corps of Engineers. The Army Special Forces of the United States provide mobile training teams to advise military and para-military units on a wide variety of civic action as well as on warfare and counterinsurgency. Engineer detachments, in addition to their combat service, provide technical advice and instruction on such subjects as building and road construction, and on civil, mechanical, and military engineering problems. This article describes the work of some of these teams. There is a particularly detailed account of the manufacture and use of soil-cement blocks for construction. These blocks, formed of earth and cement, are good for the provision of low cost housing. The heart of the technique is a block press which was specially developed by the Inter-American Housing and Planning Center in Bogota. The description is very full and well illustrated.

J.S.W.S.