THE ROYAL ENGINEERS JOURNAL

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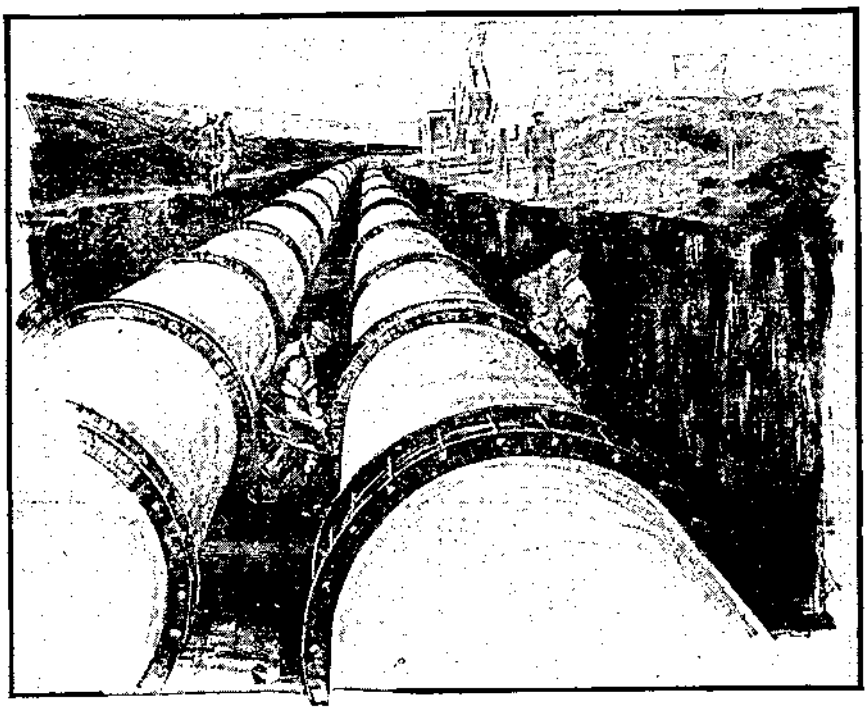
CONTENTS

Message from the President, Major-General T. H. F. Foulkes		1
To the Danube by Heavy Ferry	Major A. C. S. Ross	2
Sappers in the Borneo Campaign	Major G. W. A. Napier	10
Water Supply Improvements at Hiron	Lieutenant S. Lane-Jones	27
Submarine Sappers	A/Captain J. D. Braithwaite	33
Far Eastern Outpost	Lieut-Colonel R. S. Hawkins	37
Institution of Royal Engineers		48
The Royal Memorial Chapel, Sandhurst		46
Correspondence		49
Memoirs, Book Reviews, Technical Notes		50



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VOL. LXXXII **CONTENTS** MARCH, 1968

		PAGE
1	MESSAGE FROM THE PRESIDENT, MAJOR-GENERAL T. H. F FOULKES, CB, OBE, TO ALL MEMBERS	1
2	TO THE DANUBE BY HEAVY FERRY. BY MAJOR A. C. S. ROSS, RE MIPlante, AMBIM	2
3	SAPPERS IN THE BORNEO CAMPAIGN. BY MAJOR G. W. A. NAPIER, RE (*With Photographs and Maps*)	10
4	WATER SUPPLY IMPROVEMENTS AT HIRON, WADI AIDAM, DHOFAR PROVINCE, OMAN, AUGUST 1967. BY LIEUTENANT S. LANE-JONES, RE	27
5	SUBMARINE SAPPERS. BY A/CAPTAIN J. D. BRAITHWAITE, RE (*With Photograph*)	33
6	FAR EASTERN OUTPOST. BY LIEUT-COLONEL R. S. HAWKINS, RE (Retd), MA, AMIMechE (*With Photographs*)	37
7	INSTITUTION OF ROYAL ENGINEERS	48
8	ROYAL MEMORIAL CHAPEL	48
9	CORRESPONDENCE	49
10	MEMOIRS	50
	MAJOR-GENERAL SIR DONALD J. MCMULLEN, KBE, CB, DSO	
	BRIGADIER R. C. R. HILL, DSO (*With Photograph*)	
	BRIGADIER T. H. EVILL, CBE, DSO	
	COLONEL W. T. EVERALL, OBE, MICE	
11	BOOK REVIEWS	61
	ARMOURED CRUSADER	
	STRUCTURAL LIGHTWEIGHT AGGREGATE CONCRETE — R.C.G.	
	DATA AND FORMULAE FOR ENGINEERING STUDENTS — F.T.S.	
	DIRECT CORRELATION OF PHYSICAL CONSTANTS THROUGH TRANSCENDENTAL EQUATIONS — A.G.H.B.	
	ADVANCED ENGINEERING THERMODYNAMICS — F.T.S.	
	GREAT IDEAS IN INFORMATION THEORY LANGUAGE AND CYBERNETICS — F.T.S.	
	BASIC ELECTRIC CIRCUITS FOR ENGINEERS — F.T.S.	
	ENGLISH STUDIES SERIES 5 (MILITARY TEXTS) — F.T.S.	
	THE UNIVERSAL ENCYCLOPEDIA OF MACHINES	
	APPLIED HYDRODYNAMICS — F.T.S.	
	MECHANICS OF MACHINES — F.T.S.	
	SOLDIERS IN THE AIR—THE DEVELOPMENT OF ARMY FLYING — N.A.F.E	
12	TECHNICAL NOTES	67

Message from the President, Major-General T. H. F. Foulkes, CB, OBE, to all Members

DURING 1967 I had the privilege, as Representative Colonel Commandant RE, of visiting, with my wife, many units and establishments of the Corps in Europe and in the Near, Middle and Far East, as well as Sapper friends in India.

It was most inspiring to see at first hand the excellent work of all ranks—some of it in conditions of hardship and danger—their splendid spirit, and the high regard in which they are held by people of many nationalities: though this was nothing very new to me as a former Engineer-in-Chief.

At the same time, I could not help noticing with regret how some of the old links between the Armed Forces of the Commonwealth are being weakened with time and disuse; and recent events have, unhappily, done nothing to repair the damage.

In such circumstances, I feel that the Institution and our *Journal*, which is very widely read, are valuable instruments in maintaining contact between fellow military engineers, brothers-in-arms and old friends, and it gives great satisfaction to read in the RE List the names of Corresponding Members (to whom we are especially indebted), Honorary Members, Members and Associate Members resident in many different countries of the World.

While specially thanking overseas Members of all categories for your support and sending you the best wishes of the Council for the future, I would like to offer you two suggestions: firstly that you send us contributions for publication in the *Journal* from your own experience in countries where British Sappers no longer serve, to add to its wide interest and variety—they need be neither long nor complicated; and, secondly, that you not only continue to support the cause of long-standing liaison and friendship by your own membership, but that you endeavour to bring in others to augment and continue the good work.

The Secretary is publishing elsewhere in this *Journal* conditions of membership.

To the Danube by Heavy Ferry

MAJOR A. C. S. ROSS, RE, MIPlantE, AMBIM

IN August 1967 23rd Amphibious Engineer Squadron went on a three-week tour of Western Germany, from Denmark to Switzerland, bridging and ferrying on the major rivers as they were reached. The exercise, Crimson Carbine, was a test of all departments of this independent squadron, which planned, reconnoitred, administered and executed the task on its own.

This short article outlines the exercise.

The first piece of paper mentioning Crimson Carbine was the 1967 Squadron Training Programme issued in December 1966. At that time the project seemed so far away and so unlikely to materialize that it was not taken too seriously. The OC started reconnaissances in February 1967 and by the end of March the outline was clear. Squadron training went on. We took delivery of four M2 Amphibians and learned a bit about them. The squadron went to Oppenheim on the Rhine for bridge camp in April and from there the 2nd Troop Commander and Recce Sergeant were sent out to look for possible sites on the River Neckar. We already had good links with the French Amphibious Engineers further up the Rhine, so asked them to join us at Oppenheim and then discussed a return visit in August.

The Amphibious Troops each take a month's block leave in the summer, so we decided that as the aged Gillois would find the 1,500-mile trip hard going 1st (Gillois) Troop would go on leave and Squadron Headquarters, 2nd (Heavy Ferry) Troop, 3rd (M2) Troop and the Support Echelon, including elements of the Squadron's REME Workshop, would take to the road.

Further recces were made and BAOR Form 443 submitted. It is easy to write it like that. In fact, 196 traces had to be drawn and the distribution included twelve LLOs, SLOs and Liaison Headquarters. We were almost on Christian-name terms with the girl operators at Villa Spiritus, the JSLO Headquarters in Bonn, and we filled files with letters negotiating for petrol bowsers, petrol coupons (where can you change 500-litre diesel coupons near the Black Forest? We had to find out), crane, tug, and Class 30 trackway, RCT drivers and 10-tonners to carry the Heavy Ferry; rail transport to bring the amphibians and HF main pontoons back from Bavaria; chains to lash the equipment to the rail flats, the loan of an excellent Tels Mech and a Radio Workshop vehicle, and ration cash allowance instead of 100 per cent Compo issues.

The Movement Control people wanted to know our exact routes, as we have "out-of-gauge" loads, but apart from Autobahn trips to get us to our start point and home from Bavaria the OC had intentionally not allowed detailed recce. The route was roughly down Route 3, but each troop was to recce its own routes from river to river. The M2s are 40 ft long and nearly 10 ft wide; the dozer train is class 56 and the Heavy Ferry power pack is over 14 ft high. We have found we cannot trust outsiders' recce, and as roadworks and diversions can nullify earlier recce the only safe course was to do it as we went along. At one stage of the planning a German clerk informed us that the Americans would not let us into their zone unless we could give exact route and time. We said: "That's OK. We're carrying arms and bayonets; we reckon we'll get in." The Americans, knowing nothing of this, of course, fell over themselves to help us over sites, bivouac areas, PXs, everything.

In about May the OC thought that perhaps we should have an authority other than his own for the exercise. After a cautious letter to HQ 11 Engineer Brigade authority was given, but we still do not know who really gave it.

Within the squadron there was quite a bit being done to prepare maps of most of Germany showing out-of-bounds areas (water catchments, game reserves, etc.), boundaries and nicknames, sorting out ration strengths, getting vehicles and radio

stations properly kitted and so on. The preparations, although continuous from April to July, were by no means in the forefront of the squadrons activities. 2nd Troop supported the Belgians and 2nd Division Engineers on Exercise "Channel Link". The squadron co-ordinated and managed the Military Open Day during British Week in Hameln in June, on which eighteen units and two military bands were represented and 23rd Squadron presented three ferries (the Heavy Ferry disguised as a Mississippi steamboat), each taking German civilians on joyrides, a working workshop, sideshows, a fish-and-chip stall and most of the infrastructure. 1st (Gillois) Troop, having been cheated out of driving the length of Germany in their amphibians by being sent on leave, cycled on the thirty squadron bicycles from Aschau on the Austrian border to Kiel.

On 20 and 21 July we organized and ran the BAOR Canoe Championships, and a week later we were off, heading north to Denmark.

As will be realized, all the hard work to date had been done by the 2IC, with the OC giving vague directives and journeying about the country tramping riverbanks. The 2IC now went off on a Military Law Course and a visit to RE Records, leaving only the OC in command! It says much for the Troop Commanders that all went well while he was away!

EXERCISE CRIMSON CARBINE

Saturday, 29 July. About 100 soldiers with three officers motored from Hameln to Westre (260 miles), just on the Danish border. Apart from some scout-car overheating, all went well, and we had an evening meal in the dusk in a very friendly farm. The next day, Sunday, parties went off to Denmark (by special arrangements with the Danish customs, who let us take 4-tonners in) and to the Island of Sylt. They got back for a tea meal and then went to a local dance. Some of us went into Flensburg. The object of this jaunt was to give a starting-point for the exercise—Denmark.

On *Saturday, 29 July*, too, the heavy equipment, consisting of four M2 Amphibians, a complete Heavy Ferry train, Workshop vehicles, two fuel bowsers and trailers, together with office truck, stores vehicles and recovery vehicles, went direct from Hameln to Gultzow, a village north of the Elbe not far from the East German border. Here they installed themselves in one of the most prosperous farm complexes in Germany and were well looked after. Hot baths were available. Officers and sergeants were all offered rooms in a hunting lodge, and later one of the officers was asked back for a holiday with his wife and family. We drank much of their sekt and a fair bit of their gin and tonic. It was that sort of farm. Sunday for this group too, was a rest day and they visited local towns and Gasthouses.

Monday, 31 July. The troops from the Danish border joined their heavy equipment and we got ready for work. The squadron then consisted of 6 officers (1 major, 2 lieutenants and 3 2nd lieutenants), 150 soldiers and 75 vehicles. We became "tactical" at 1200 hrs, with the normal implications in respect of camouflage nets, arms, respirators, sentries, radio security and code words.

Tuesday, 1 August. In a grey dawn and pouring rain we set off to cross the River Elbe. The Heavy Ferry led and built at Artlenburg. The build took about an hour and when they had almost finished the M2s went in and made a ferry. The river there is about 1,000 ft wide, so a round trip took about fifteen minutes. We had cleared across all the squadron vehicles including the Scammel and trailer by eleven o'clock. The most impressive load was three 10-tonners nose to tail on the Heavy Ferry. Two of the M2s were holed quite badly on the stone setts of the civil ferry site and one had taken about 1,000 gallons of water into a sideswimmer (over and above what the bilge pump had pumped out). It was well down in the water, but quite stable and we carried on using the rig until all vehicles were over.

We went into harbour east of Luneburg and the welders got busy with the Argon arc equipment. By the time the Heavy Ferry had been extracted over the Elbe flood bank, loaded and moved and been camouflaged it was evening.

Wednesday, 2 August. The squadron moved off during the morning, via Luneburg

and Soltau, to a site near Winsen on the River Aller. We had an evening meal about five miles back from the river and the M2s went forward at last light. The river at this point was 110 ft wide, so the four M2s, which can span 125 ft, could bridge it easily. The Heavy Ferry and all the other transport crossed the M2 bridge and all went well until a vehicle bogged in the pouring rain at about midnight, and the rest of the night was spent moving the bridge, re-laying class 30 trackway and winching.

Thursday, 3 August. All vehicles were clear of the site by 0630 hrs and we set off on the 110 miles to our next obstacle—the Weser. The soldiers slept on the move, drivers were changed and recce sergeants tried to keep ahead to make sure there were no low bridges or detours. Each troop moved and fed independently. The M2 and the Heavy Ferry both ferried vehicles that night, on sites about two kilometres apart between Hann Munden and Vaake.

Friday, 4 August. All equipment was across the Weser and out of the water by 0500 hrs. We slept during the morning and made ready to be off after an early lunch. We had all carried personal arms until now, but were not going to take them into the American zone, so had to organize their collection, checking and return to Hameln. We had by now solved the bureaucratic objections to entering the US zone and the arms went off locked in a Binned Truck escorted by two scout cars.

During the afternoon we motored south for 125 miles to Hanau, where the Americans had earmarked a section of their wooded training area very close to their barracks complex for us.

Saturday, 5 August. The FRTs had worked most of the night getting the M2s holes patch welded and mechanical adjustments made. During the day the equipment went on the River Main, but the site reconnoitred and selected had not been accepted and the one we were allocated was a very simple one. We therefore made it a day for brushing up our techniques and did not ferry the squadron over.

The OC offered the men with families in Hameln a "24", but of the married men only twelve opted to go home for the night. This took some explaining to the wives of the men who stayed away, but we published a convenient list of duties to cover the men's predicament.

Sunday was a maintenance day and much grease was pumped into prop shafts and various parts of various chassis. The Saturday and Sunday were also available for sightseeing in Frankfurt and Offenburg. The Americans showered us with hospitality. We used their clubs, were asked to parties and into their homes, and stocked up our cookhouses with food brought from the PX. We were reluctant to leave Hanau.

Monday, 7 August. We motored through some of the most beautiful country in Europe, the Odenwald and the River Neckar valley above Heidelburg. Arriving at Mosbach at about 1700 hrs, we had a meal and an O Group and sent forward recce parties. Only 2nd Troop Commander had seen the sites, and everyone else, including the OC, saw them for the first time only just before, or in the case of sappers, just after last light. The Neckar has many weirs and flows very slowly. This makes control of the M2 difficult, as the pilots must keep alternating ahead and astern with their propellers. Both the M2 and the Heavy Ferry had quick builds and ferried well. It was technically the best night of the exercise. Our Brigade Major visited us and for once all went well despite visitors.

Tuesday, 8 August. After crossing, the squadron slept in woods on the hills to the west of the Neckar and set off at about 1000 hrs for the long haul to Rastatt, the home of the French Amphibious Engineers. The distance, ninety miles, does not sound far, but finding a route across the hills to Karlsruhe took most of the day. The 22-ton M2s were reported to have crossed a 15-ton weighbridge which had been left "cocked" and springs and balance weights were said to be strewn all over the street. A Heavy Ferry main pontoon collected a traffic-light standard as it passed it in Karlsruhe and, the only serious accident in the whole exercise, a 4-tonner cooks wagon got out of control on a steep hill in the Black Forest and overturned. No one was seriously hurt. We got to the River Rhine south of Rastatt in time to set up a squadron camp on the river-bank and have a swim in a lake before the evening meal.

Wednesday, 9 August. The day was spent ferrying on the Rhine. The equipment was put in on a dead arm of the river and this almost resulted in the loss of the Heavy Ferry. The Gill jets sucked up weed and flotsam, blocking the tubes and restricting the speed to about one knot. Luckily the raft commander had sense enough to return to the building ramp before he reached the 4-knot Rhine. The power packs were taken out of the water by crane and the water intakes were cleaned out one by one. At the second attempt the ferry was taken down away from the weeds by tug before starting the power packs. There was then no problem. The troop set off across the Rhine from Germany, landed in France, discussed desertion, but agreed that there was probably an extradition agreement, so motored back. This was also a maintenance day for all the transport—and for the soldiers; we had showers in the French Army barracks in Rastatt. The regiment there also invited our Officers and all NCOs to a "*vin d'honneur*" to toast our mutual success, brilliance and national respect for each other.

Thursday, 10 August. Excursion day. Parties went off to neighbouring towns, to the Black Forest, to the local shops and the swimming baths and to the Rhine Falls at Shaffhausen on the Swiss border. The Rhine Falls, which are the largest waterfalls, by volume, in Europe, were some ninety miles south, but they were an obvious point for the soldiers to go to. We had started in Denmark; we would finish in Switzerland. But we had not finished.

Friday, 11 August. The squadron made an early start for its longest day's march —210 miles to the Danube. Most of the route was along the Autobahn, by Karlsruhe, Stuttgart, Ulm and Augsberg; then north to Neuburg. We finally got in to our harbours, complete but tired, at 2100 hrs. As with some of the other moves, we had absolutely no idea where we were going to harbour that night when we left in the morning. The OC, who knew the river crossing site, indicated a general area of about ten by ten kilometres and told the headquarters subaltern to co-ordinate the troop recce sergeants and do the best he could. Troop cooks vehicles acted as rear party vehicles; the cooks cleared up the last site and then hot-footed it to try to get into the next harbour to cook before the main party arrived. There was an exception on this day's move. We expected to be on the road for twelve hours so sent a cooks vehicle to a lunch rendezvous where we all had a welcome hot lunch, with choice of meat and three veg, near Ulm. The squadron was too big to fit into Autobahn lay-bys, so we turned off on a ten-mile loop and rejoined the Autobahn later.

Saturday, 12 August. The M2 and Heavy Ferry at last reached their goal—partial immersion in the Danube. For the Heavy Ferry it was almost total immersion.

Due to the fast current (5 knots) we decided to build a "slim jim" ferry, i.e. only two main pontoons instead of four. It is enough to carry "B" vehicles, but the power –weight ratio is much better. This nearly proved disastrous, for as soon as the mains were end-coupled and pushed out ready for the power packs to be joined, the strong current took the pontoons and turned them on their sides. The soldiers all jumped or fell into the water, but clung to breastlines and were in no difficulty. We dragged the mains out, separated them, turned them on their bottoms and started again. The whole thing did not take long and the ferry was built, used, stripped, loaded and back in harbour by mid-afternoon.

One M2 had a few problems when the main propeller drive failed as the rig went into the water. It had then only half power and no steering. By the time the tug got to it the M2 was 400 yards downstream with its anchor cable fully out and the anchor slipping from boulder to boulder. The Danube is a very fast and stony river. Eventually, while the other three M2s made a raft and ferried, the fourth one laboriously drove upstream, using only the two fixed side propellers and steered by disengaging them alternately. All equipment was in harbour by tea-time and we had Saturday night out in Ingoldstadt, Neuburg or round a camp fire.

We had crossed our seven rivers as planned.

Sunday, 13 August. On this day 263 years ago the Duke of Marlborough fought and won the Battle of Blenheim about twenty miles away from where we were. What

a coincidence that we had the day free and could go and visit the site. The coincidence had been arranged some months before and had since been the subject of much correspondence, reading, planning and reconnaissance. The Military History Staff at the RMA Sandhurst had helped us enormously with maps and interpretations of the battle. An RMA lecturer had agreed to talk to us on the site, but was finally prevented from coming. We had a University OTC Cadet, who came out primed with all the statistics and facts on horses, equipment, impressment of carriages, billeting arrangements and so on. And the Squadron 2IC, who had recently become an MA in engeering, was discovered also to be a military historian. He rejoined us from his Law Course while we were on the Rhine, showed amazement that we had got so far unscathed, and he went ahead to the Danube to walk the battlefield and select viewpoints.

Thus we spent the anniversary morning of the battle walking around the low hills of Blenheim and learning how Prussians, French, Austrians and British managed to get over 100,000 men facing each other across the Nebel marshes. Three stands, two hours, many jokes and some most interesting facts later and we were all drinking in the inns of Blenheim, wondering where on earth they had billeted fourteen battalions. Our squadron seemed to fill the place even without our bridging kit.

On Sunday afternoon some of the soldiers went off to Munich and Dachau. Others went to Ingoldstadt. Others got their vehicles in order for the move home.

Because the M2s were to be sent home by train their crews had nowhere to travel. Some of the men offered to hitch-hike the 400 miles home, so, after an inspection by the HQ Staff Sergeant—the SSM was on leave throughout the exercise—an issue of twenty-four hour ration packs and a warning not to do anything which could possibly contravene any orders which may have been issued about hitch-hiking, about twenty soldiers set off in pairs. The first reached Hameln that night, the last within thirty-six hours.[1]

Monday, 14 August. The M2s and Heavy Ferry main pontoons and trailers started to be loaded on railway flats at Ingoldstadt station at 0800 hrs. Loading and lashing down with chains took most of the morning. The cooks set off to prepare lunch near Nurnburg, and the OC went off to Furth to conclude negotiations with the Americans to lend him a company of amphibious engineers and their twenty Gillois rigs for the autumn manoeuvres in BAOR. The bridging crane, which had burned out its clutch about a week before, was on tow behind a 10-tonner—sometime RE, sometimes RCT, but otherwise everything was moving under its own power and in good order. The squadron stopped for the night near Frankfurt and reached Hameln on Tuesday, 15 August.

It took us eighteen days. We visited four countries, saw the North Sea, the Baltic, Munich, the American, German and French Armies, and the major rivers of Germany. Most of the vehicles covered over 2,000 miles. Some of the recce vehicles topped 3,000 miles.

The officers, apart from the OC, were all in their first season with troops. There was only one disciplinary case—the driver who turned his vehicle over in the Black Forest—and only minor injuries. We returned to Hameln tired but happy, knowing that after Crimson Carbine the problems of the three autumn FTXs would be easy in comparison.

[1] The first soldiers back in Hameln were Cpl Kelly and L/Cpl Shackleton (a potential Clerk of Works). They had made friends with a German in Neuburg who was waiting for them at our harbour area to take them to the autobahn at 1400 hrs. On the autobahn they got a lift with an American to Wurtzburg and immediately a German who was going to Darmstadt took them to the Frankfurter Kreutz. There they got a lift from another German in a three-litre Opel Kapitan who was inveigled into showing off by cruising at 200 kph to Alsfeld. Here the two corporals went for a cup of coffee (about 7 pm) at the autobahn restaurant and met a British Officer with a Rover who was returning from St. Moritz to Herford. He brought them right into Hameln where they arrived at about 2230 hrs. They say that their total waiting time was less than half an hour so they averaged about 50 mph. As the trip was mainly on the autobahn and was in fast cars this is reasonable.

Photo 1. An M2 Amphibian going into the water.

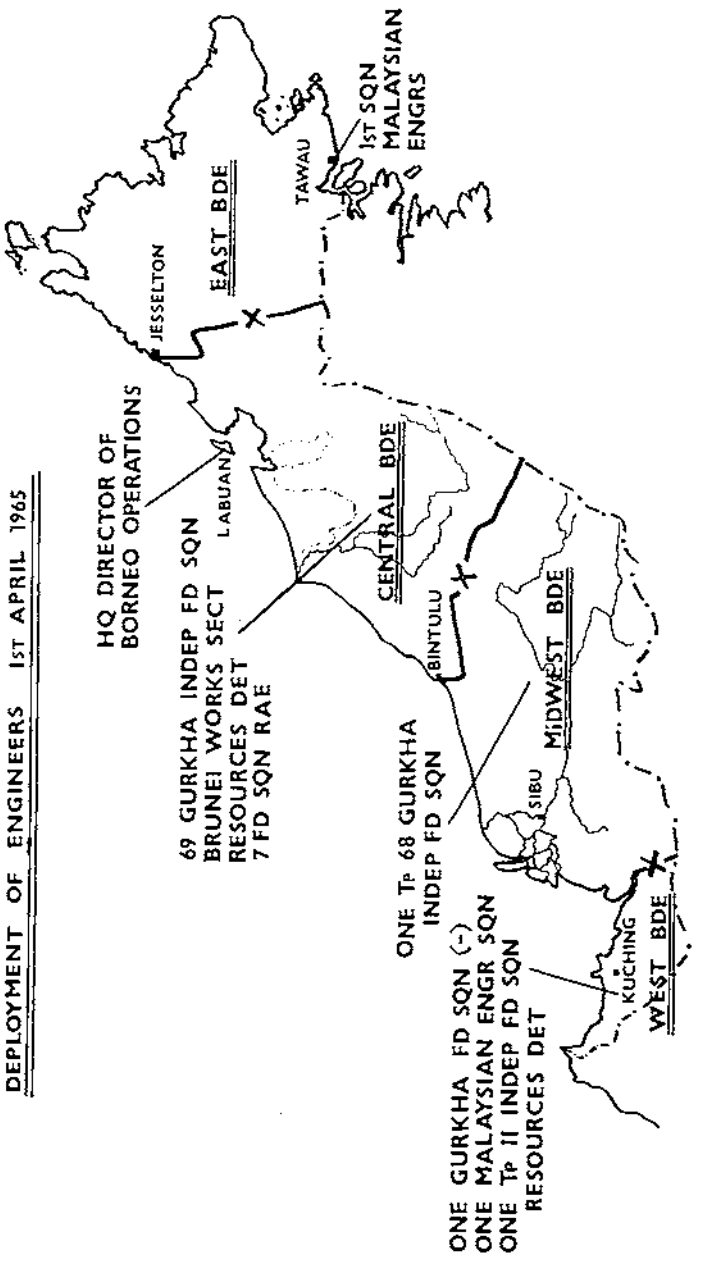
Photo 2. A three rig M2 ferry, capable of carrying Class 60 loads.

To The Danube 1 & 2

Photo 3. An M2 Amphibian. 10 feet wide, 37 feet long, weighing 22 tons with a crew of four

Photo 4. In the Neckar Valley above Heidleburg, near Neckarelz.
Heavy Ferry on the move.

To The Danube 3 & 4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Sappers in the Borneo Campaign

MAJOR G. W. A. NAPIER, RE

INTRODUCTION

THREE previous articles have recently been published in the *RE Journal* on the subject of engineer work in Borneo. These concentrated on Gurkha Engineers' activities, and primarily with operations in the Central Brigade area, with the emphasis on the difficulties created by dependence solely on air supply. This article aims to give a wider version of the Borneo story, showing how we as Sappers reacted to the varying operational demands; what problems arose and how they were solved and shelved, bringing out any lessons that were learnt.

Few of these lessons are new ones; nor is it suggested that the lessons have a universal application to future campaigns. They are set out for the benefit of those who may wish to learn from them or discuss them.

No attempt has been made to go into technical detail. This is all available from the normal official sources. This record merely aims to give the broad historical facts and to highlight, function by function, the main engineering problems that faced Sappers in Borneo.

OUTLINE OF EVENTS

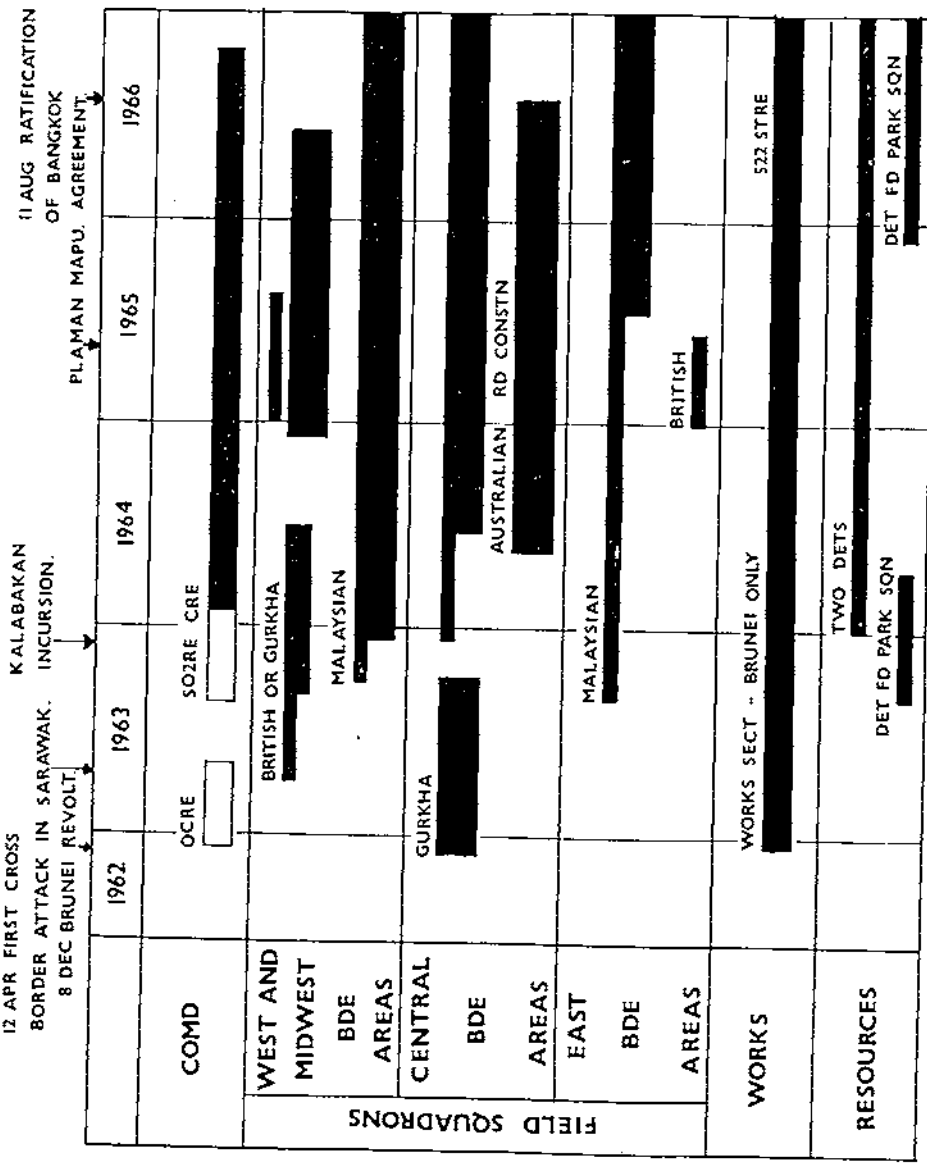
The Borneo campaign started with the Brunei revolt in December 1962. At that stage Sarawak and North Borneo (now Sabah) were still under British administration, though earmarked to become part of Malaysia later on in 1963. Brunei, financially independent, thanks to oil, elected to remain outside Malaysia. The revolt had the ultimate aim of setting up a unified independent state of North Kalimantan, incorporating Brunei, Sabah and Sarawak. The teeth of the revolt was the so-called National Army of North Kalimantan (TNKU) led by Asahari and supported and armed by Indonesia.

The British Army reacted immediately with the now historic action which dramatically put an end to Asahari's aspirations. The shooting war was over in five days, and early in the new year (1963) the force of approximately brigade strength was merely hounding down the stragglers. Engineer support in this phase was provided by 69 Gurkha Independent Field Squadron, an ad-hoc Works Section introduced to revive and control the PWD, a troop of 54 Corps Field Park Squadron and various Movements and Transportation elements now under the Royal Corps of Transport. Engineer activities were co-ordinated by an OC RE on the Force Staff, and CRE 17 Division was borrowed for about a month.

The lull was abruptly broken by the first armed attack across the border by Indonesia, at Tebedu, in April 1963. This moved the emphasis of operations into Sarawak and a brigade size force was despatched there with, in support, a troop from 11 Independent Field Squadron, under engineer command of OC 69 Gurkha Independent Field Squadron.

Confrontation was openly declared on the formation of Malaysia in August 1963 and Commonwealth troops became involved along the entire 960-mile border with the vicious attack on Kalabakan, a frontier post in the eastern corner of Sabah, in which nineteen Malaysian soldiers were killed.

The engineer force gradually built up with the Malaysian Engineers coming on the scene in late 1963, two Resources Detachments in January 1964, a CRE and Staff (at last) also in January and, though not initially connected with Confrontation, an Australian Field Squadron on a road construction task in Sabah in May 1964. The deployment of engineers on 1 April 1965 is shown on the map, and so it remained with minor variations until the end of Confrontation in August 1966. Also


BUILD UP OF ENGINEER UNITS
BORNEO 1962 - 1966
12 APR FIRST CROSS BORDER ATTACK IN SARAWAK.
8 DEC BRUNEI REVOLT
KALABAKAN INCURSION.
PLAMAN MAPU. AGREEMENT.
11 AUG RATIFICATION OF BANGKOK AGREEMENT
1962
1963
1964
1965
1966
COMD
OCRE
SO2RE CRE
FIELD SQUADRONS
WEST AND MIDWEST BDE AREAS
BRITISH OR GURKHA
MALAYSIAN
CENTRAL BDE AREAS
GURKHA
AUSTRALIAN
RD CONSTN
EAST BDE AREAS
MALAYSIAN
BRITISH
WORKS
WORKS SECT - BRUNEI ONLY
522 STRE
RESOURCES
TWO DETS
DET FD PARK SQN
DET FD PARK SQN

on the map are the brigade boundaries at the time. A list of the engineer units which took part in Borneo operations is at Table 3.

The rate of build-up of engineer units was not as fast as it should have been. This is illustrated in the diagram. The most outstanding points from this are the scarcity of engineers in 1963 compared with other arms, and the lack of a CRE until 1964. There is no doubt that later engineer operations were severly hampered by these deficiencies and that, to some extent, the image of the Corps suffered slightly as a result. This tarnished image was, however, largely offset by the excellence of the close engineer support that all arms received.

In fact, the staff had been advised in December 1962 to bid for a CRE and field squadron to be put at short notice to move from UK. But at that time the Brunei revolt was being quickly defeated, all was quiet elsewhere, and the withdrawal of the brigade from Brunei was planned for April '63, until the Tebedu incident shattered these hopes. After this, the threat fluctuated, and continual demands for engineer reinforcements by the CE, supported by the E-in-C at the War Office, were turned down by Far East command, until in November it became crystal clear that hostilities would continue, and the approval on 25 November of Op CROWN made reinforcements from within the theatre out of the question.

The real trouble stemmed from the lack of a properly constituted Force HQ in being, and capable of taking the field. The problems of command are best stressed by this extract from the Chief Engineer's official report on the events of 1963:

" . . . In the case of Brunei, all the evils of improvization were apparent in the obvious necessity for finding somehow a force HQ—COMBRITBOR. Instead of a CRE being on the spot from the start, Commanders needed to be persuaded afresh that they needed engineer advice—an astonishing necessity which always grows up in peacetime. A major was found to act as OCRE. He was one of several RE majors, and it would have been best to give him local rank as CRE, to make his position and authority quite clear. This was indeed proposed, but rejected by the GOC for reletively unimportant reasons. Had this been a regular HQ the question would never have arisen. . . ."

THE COMPANY BASE

Much of what follows will not be understood without a brief description of the tactical concept in which the Borneo operations were conducted. The 960 miles of border were covered by twelve battalions plus supporting arms which were under command of the four brigades shown on the map. The key to success was the domination by patrolling of the border area so that rapid action could be taken as soon as an Indonesian foot was placed over our side. The patrols operated from company bases close to the border, to which they would return after anything up to a fortnight out in the jungle. At any one time a company might have about two-thirds of its strength out of the base on patrol and the remaining third in camp so called resting. This pattern would continue for the four or so months for which a battalion occupied a particular area.

The rest period itself was hard work, involving guards, retraining, and refurbishing of field defences and buildings. It was therefore essential for the company bases to have whatever amenities it was possible to give them. There must be adequate refrigeration, electricity for lighting and cinema projectors, showers with hot water, latrines and so on.

At the same time, these bases were all tactically sited. Almost invariably they were at the top of a hill, which added to the problems of water supply. The field defences had to provide good, well-protected fire positions as well as being reasonably comfortable to live in.

Finally, over half of the company bases could be reached only by air or river. Many had their own Tac T(SR) strip for resupply and reinforcement and all had their helicopter pads. This is the background against which engineer work was undertaken.

ENGINEER TASKS

Borneo was no exception to the rule that primary task of field sappers is the support of other arms. The only problem was whether this support was to be given directly, by placing units under command of formations for all purposes; or, indirectly, under the control of the CRE. Decisions on the larger projects were made centrally at force headquarters in Labuan, as was the allocation of resources and specialists, for obvious reasons of economy; on the other hand, the brigades enjoyed a fair degree of autonomy in their own areas and this, plus the difficulties of communications, made it necessary for them to have their own Sappers.

The best solution was found by placing the squadrons under the command of the CRE, but giving each brigade a troop in direct support. In practice many of the so-called CRE tasks, such as works services, were also direct support and the distinction between brigade tasks and CRE tasks was a fine one. Nevertheless, it was not until engineer planning was centralized that the best use was made of the available resources or that much progress could be made towards such matters as obtaining proper park support, improved equipment particularly for water supply and an effective works organization.

It is worth recording here that the command status of units was further complicated by the fact that units from three different national armies were present: British (including Gurkha), Australian and Malaysian. From the very start the Malaysian units were placed under command of the CRE, a fact which was much envied by other arms and services and which reflected the excellent working relationship between the British and Malaysian Engineers.

The main engineer tasks in Borneo were as follows: maintenance of mobility; by far the biggest, covering roads, airfields, LZs and DZs and the supply of boats and outboard motors; water supply, probably the most important for reasons of health and morale; field defences, mine warfare, the provision of engineer resources and works services. These tasks are discussed below. The only major omission is Survey. Since well before the start of Confrontation two topo troops from 84 Survey Squadron had been working in two areas of Borneo establishing the control for the production of the 1 in 50,000 maps. This exceedingly arduous, exacting and often dangerous work was already beginning to bear fruit by the end of the campaign in the shape of excellent 1 in 50,000 maps in some border areas.

MOBILITY—ROADS

The list of major road tasks carried out by military engineers is given in Table 2. Altogether the effort involved in these projects was 191 troop months, or, on average, about six and a half troops, out of a total availability of never more than fifteen, permanently allotted to road construction. It can be seen from the completion dates that virtually no operational value was obtained from these projects at all. In the case of the two operational "jeep tracks" the bases which they were designed to supply were withdrawn before the roads were complete. All were a maintenance headache until they could be handed over to the PWD.

Apart from plant, which will be discussed later, the main problems were the weather and the lack of suitable construction materials. The former was generally appreciated before work was undertaken, although sometimes chances were taken with the climate which did not come off; the latter was not generally known.

Stone turned out to be of poor quality, very scarce and, in one case, non-existent. The type of soil over which the roads ran was for the most part a silty clay with little cohesive strength when wet. Despite efforts at compaction, fill would slide away down the valleys after heavy rain, leaving yawning gaps to be repaired. Any work skimped with inadequate shoulders was doomed to failure. The lesson was that alignments had to be chosen to avoid embankments and to keep to high ground, even if this meant more work.

Photo 1. A Company Base in East Brigade supplied by river. Note the Assault boats and outboard motors, also the single 105 mm gun, a feature of these forward bases where the gunner doctrine of never splitting sections was broken.

Photo 2. Plaman Mapu Company Base. The attack on this position in April 1965 led to a reappraisal of field defences.

A major difficulty was dissuading our customers from asking for cheap, quick roads such as "fair-weather jeep tracks". These inevitably led to huge maintenance bills, and the problem of stopping heavy traffic using them in wet weather was insuperable. The aim was always to build a road to PWD standards which they would ultimately take over for maintenance.

Finally, it is questionable whether roads are even desirable in a situation such as existed in Borneo. In the border area they would have been an ideal target for mining and ambush, as in Aden. The Indonesians never exploited this aspect. This, set against the effort required for building and maintenance, argues in favour of airstrips for operational purposes. In the short term this must be right.

Photo 3. Pilot track.

Photo 4. Side hill cut at Landing Point III. Mile 58.7.

Photo 5. Still in Progress.

However, ultimately, it is only the roads that really open a country up and bring the means of government and economic expansion to the people and these considerations may weigh more heavily than any immediate operational value. By far the biggest of the Borneo military-built roads was such a case. This was the Keningau–Sepulot road built by the Royal Australian Engineers, a prodigious task resulting in sixty miles of road through some of the most difficult terrain in Borneo and involving a complete field or construction squadron group for two and a half years.

MOBILITY—AIRSTRIPS

Altogether fourteen airstrips (see Table 1) were built during the campaign and except for one all were Twin Engineer Pioneer (TEP) strips. Judging by the fact that these were ready for use well before the end of Confrontation, they appear to have given a good return for the effort put into them. This presents a slightly false picture, as some which were not well sited were not used as much as they might have been.

The subject of airstrip construction has been well covered in previous articles and it is therefore only necessary to make a few extra points now. First, we re-learnt the lesson that careful recce and estimation is essential, and the importance of having on the initial siting board an RAF representative who is a pilot of the type of aircraft which will eventually use the strip. Second, airstrips took a long time to build, from three to nine months. In Borneo sites for airstrips were extremely hard to find and, at best, required considerable quantities of earth moving, often using small quantities of light, vintage plant.

MOBILITY—PLANT

This section is concerned only with the British plant and the general lessons which were learnt from its use. Both the Australians and the Malaysians had their own new plant which was the envy of the British Sappers who worked with them. British units used their own G1098 machines greatly reinforced from the Chief Engineer's pool in Singapore. The pool in Borneo comprised about one hundred items of enormously varying makes, marks and ages and, as a result, many troubles were experienced.

Every user of plant suffers from a lack of spares and we were no exception. Moreover, the difficulty of communications and the remoteness of the sites aggravated this. By the end of the campaign much had been done to alleviate the situation but the main points learnt are made here:

Photo 6. Long Akah airstrip. Originally a mission strip, rebuilt by 69 Gurkha Indep Fd Sqn after an accident to a Twin Pioneer. Plant for the task was air dropped, the PSP was brought in by long boat.

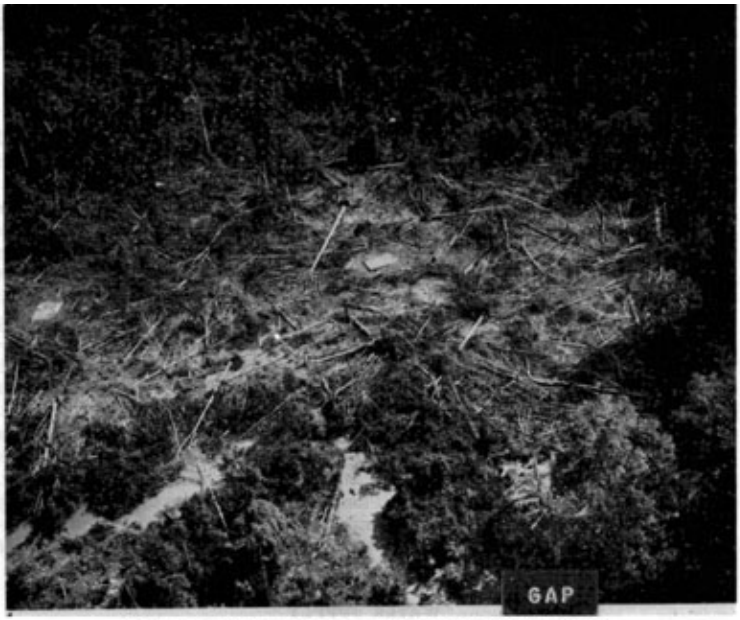


Photo 7. A helicopter base in thick forest country in Sabah.

(*a*) Some of the machines were so old that even the manufacturers could no longer provide spares. Plant should not be left sitting in stockpiles round the world, quietly growing obsolete.

(*b*) Units, while able to look after their own FAMTO, were unable to set up proper FAMTO stores for their pool plant. This should be held centrally in a field park, but there was none in Borneo until December 1965. A small FAMTO on the CES of each machine should accompany the machine into the theatre, as already happens for RE plant.

(*c*) Endless time was wasted in the search for spare parts lists and EMERS. These, also, should be on CES.

(*d*) The divisions of spares between Ordnance and RE supply and between unit and field repair spares are too subtle for units operating under pressure. There must be only one source of supply for all spares.

Repairs, were, of course, carried out forward. This work was greatly hampered by the lack of REME fitters (trained C vehicles). Throughout the campaign there was none. However, a pool of RE plant fitters was available, ostensibly to carry out unit repairs on pool plant, and they made up for this shortfall with the full co-operation of REME, who gave them access to the RAOC stores sections in the field workshops. A joint RE/REME report was eventually submitted on the organization for repairs and spares in a situation such as Borneo. This recommended that increments be made to REME workshops when pool plant is deployed, proportional to the extra dependency; that the workshops must be capable of producing Forward Repair Teams which would be placed under engineer command for specific projects, and that REME must increase their overall availability of fitters trained on C vehicles.

Many of our plant troubles stemmed from the lack of a field park. The problem of spares for pool plant has already been mentioned; also, there is always a need for a

park to which a squadron can return a machine when it is not in use between projects, so that they are not lumbered with equipment which they do not want and cannot maintain. This park is also a base for the fitter teams and a handling organization for plant entering or leaving the theatre.

MOBILITY—BOATS AND OUTBOARD MOTORS

An important Sapper task in Borneo was the provision of boats and outboard motors (OBMs) to all arms for patrolling and for logistic purposes along the main waterways of Borneo.

The Johnson 40 was agreed as the standard OBM in 1964 and large buys were made which enabled all requirements to be met. These engines were worked far beyond their normal rate and were kept going at great cost in spares. These were paid for on the authority of the CRE and at one time enough money was being spent on spares per year to buy 130 new machines, or about eleven per month on a total holding of about 240. This may seem incredible, but unfortunately spares were easily obtainable and new machines were not. Thus units would hang on to a motor, preferring to patch it up rather than be without it whilst awaiting a replacement. The solution would have been a casting policy for OBMs which would have ensured that a new motor arrived in a unit before the old one was sent away for its BER certificate.

The boats used were either the Mark 4 Assault Boat, modified by EBI locally to make them unsinkable; or locally purchased long boats. Although supplies of boats never failed, it was never possible to set up a proper system of inspection and repair. As a result, assault boats reached the EBI long after they were due for repair, and long boats, at least in the Rajang area, were inspected and repaired by the REME workshops. It was most galling to have to let this happen, but it was another example of how the lack of a field park made itself felt.

WATER SUPPLY

The provision of an adequate water supply was probably the most important of our tasks in support of other arms. On this depended the health and morale of the fighting troops. For various reasons water-supply problems were the most intractable and the situation was not satisfactory even by the end of the campaign.

In the early days there was no water-supply equipment other than the Millbank bag for filtration and a very few No 4 pumping sets. The first move was a buy of some 2 in Alcons, small lightweight, petrol-driven commercial pumps. It had been decided that the most important characteristic of these pumps was their lightness, which would enable them to be brought in anywhere by helicopter and also to be easily manhandled, so that they could be withdrawn inside the perimeter of a company base at nightfall. A filter was then designed and produced by the EBI to match this pump. It became known as the FARELF filter. It is a simple three-candle stella filter in an aluminium alloy casing.

However, it was March 1965 before these filters were in production and by this time many disadvantages became apparent.

(*a*) The Alcon pumps, which had been in service some time, had all become unreliable and in constant need of repair. Also, they produced too little head for most of the bases in which they were required to operate.

(*b*) The FARELF filter was by no means easy to instal and operate. In some bases where sources were bad it could not be used without backflushing every twenty minutes or less. This was a most important point, as the water-supply systems were operated by the Infantry water dutymen and not by Sappers. The more crafty operators soon discovered that an excellent flow was obtained by removing the candles.

(*c*) The requirements of the company bases were no longer 10–15 gallons per man per day as originally envisaged, but up to 40 gallons in much larger bases.

(*d*) The doctors, quite rightly, insisted that water for all purposes, not merely drinking water, was to be filtered and sterilized.

Photo 8. A typical water supply set up in a forward area.

Most of the troubles of the FARELF filter were solved by placing two in parallel. This enabled backflushing to take place and avoided operators by-passing the filter. However, the plea went out, with the fullest staff backing, for bigger and better pumps and the principle of lightness was sacrificed for the sake of reliability. Nothing suitable was available from service sources except for thirty No 4 pumping sets which were eventually winkled out of BAOR and did sterling work. A commercial diesel-driven pump giving a comparatively low output at about 200 ft/head was requested, but it was almost a year to the day from the original staff request to the arrival of the first pump in Borneo, a salutary reminder of the fact that even standard commercial pumps are not held on the shelf by manufacturers in any large quantity.

ENGINEER RESOURCES

Although Engineer Resources have been until recently the Cinderella of the Corps it is no exaggeration to say that they played a vital role in Borneo. They became as much a part of daily life as ammunition, rations and POL. Two detachments were set up in 1964, in Kuching and Brunei. They each consisted of a sergeant and two sappers with some civil labourers to help. On this slender thread every unit in Borneo depended for all their CGI, outboard motors and spares, boats, PSP, bridging, nails, wire and general building stores, to say nothing of plant and some pumps. The bulk of the material was bought locally and the average monthly expenditure for 1965/6 was about £9,500. This figure gives an indication of the responsibility borne by the two S/Sgts, to say nothing of the CRE, who until June 1965 had no officer with Resources experience on his staff.

Apart from understaffing which was later corrected, the system worked extremely well with one notable exception, and was particularly well suited for local purchase of general building stores. The secret of success was that for the CRE there was no ceiling on expenditure from Vote 7F within the normal rules. This remarkable privilege was not enjoyed by any other head of arm or service, but was essential in the circumstances, where the needs of troops in the forward areas were unpredictable, but had to be met at once. The materials purchased were all essential, but neither Ordnance nor MPBW were in a position to provide them. Difficulty was experienced over the rules and procedure for local purchase, which were the same as for peacetime conditions in a developed country. These simply did not fit the conditions and sweeping local modifications had to be made in, for example, tendering procedures.

The one exception in this successful provision of engineer resources was spares for engineer construction plant and other equipment of engineer origin. Soldiers on the ground are not aware of the distinction between spares of engineer origin and those of ordnance origin and, perhaps more important, nor are many Q staff officers. Requests for these spares were inevitably made through ordnance channels and thus were either found to be not available or obtained from the EBI and sent forward to the OMPs unless spotted quickly by a vigilant engineer staff officer. In fact, even if all demands had been correctly channelled, the resources detachments had no capability for handling or holding any number of spares. The ordnance system for handling every other spare used by the army worked extremely well and this is what was eventually used for RE spares.

Experience in Borneo showed that there is a need for a single service providing all mechanical equipment and its spares: equally, it stressed the need for retaining engineer control over the raw materials we use for construction and even extending that control to items now controlled totally by Ordnance, such as paint, rope and materials for field defences.

FIELD DEFENCES

Little thought was given to the question of field defences in Borneo until a most determined attack was put in on a company position of 2 PARA in April 1965. As a result of this the need became apparant for properly dug-in positions, instead of just fire trenches as hitherto, with protection against 60 mm mortars and rocket launchers.

For the sake of quick speed of reaction these positions were required to be combined living and fighting bunkers.

The solution we went for was the Bowen bunker, brain child of OC 68 Gurkha Independent Field Squadron. This was prefabricated from cut timber in rear areas and made up into standard packs, which were then flown forward and reassembled by Infantry in the company position. It may seem illogical, in a country where timber is the commonest commodity, to use valuable airlift capacity carrying it round the place, but it was decided that the effort was well worth while for the following reasons:

(*a*) Pre-cut timber could be mass produced in the field-park yard using standard jigs over and over again. (Here incidentally we felt the lack of a proper field park. The bulk of this work was done by the Malaysian Engineers' Park Troop.) This mass production was obviously quicker than anything that could be done forward.

(*b*) Preservation of timber could be more easily and more thoroughly carried out in rear areas than forward.

(*c*) The standard pre-cut lengths, with all the joints marked, were comparatively simple for Infantry to reassemble with minimum Sapper supervision. Jungle timber would have entailed more experts and would have slowed the process down and probably other tasks as well.

The standard of concealment of field defences in Borneo has recently been criticized in an article in the *British Army Review*. For practical reasons little effort was made on camouflage, but had a more lively threat existed much effort would have had to be taken concealing positions from the air and fire slits for direct small-arms or rocket-launcher fire.

MINE WARFARE

Mine warfare was a comparatively minor part of Borneo operations, but, like the poor, it was always with us and was ignored at our peril.

Enemy mines were invariably laid haphazardly as nuisance mines on tracks or LZs and their rarity was such that there was no question of patrol clearing a path ahead of them. LZs were normally given a visual examination as they were secured by an Infantry patrol before helicopters landed. There were altogether thirty-two mine incidents resulting in casualties to security forces or eight killed and ten wounded. The two commonest types of mines were the Yugoslav PMAI plastic mine and the American M2A3.

Mines were never used by our own troops in the convential North-West Europe fashion. The reason was that anti-personnel mines, once laid, would be virtually impossible to locate again because of the movement of soil caused by heavy rainfall and the rapid growth of vegetation. Maintenance or subsequent lifting would therefore have created unacceptable risks. Booby trapping, too, was entered into with the utmost caution and strict rules were laid down on the subject by Force Headquarters.

The most significant aspect of mine warfare was the growing liking amongst the Infantry for command-detonated mines, particularly the Claymore, for use in protection of company and patrol bases and also in ambushes. Such mines can be laid to a pattern, wired up in conjunction with flares and detonated electrically at the discretion of the patrol commander. There is an urgent need for better equipment for this technique, such as low-resistance cable and a simple water- and fool-proof ripple switch. There is also a need for training, as it was not unknown for systems to fail on account of too few amps being asked to pass through too many ohms.

WORKS SERVICES

The first requirement for Works Services arose during the Brunei Revolt, when all the public utilities in Brunei closed down. An *ad-hoc* section of specialists was formed immediately and, arriving in Brunei hot on the heels of the first wave of Infantry, enabled the Brunei PWD to get in action again. This section became

established in Brunei as the Brunei Works Section and eventually took over the whole Central Brigade Area, for which it remained responsible until April 1966. Outside this area the MPBW were responsible for all works services.

MPBW were not, of course, able to operate in the forward areas, where contractors could not be found. Even in rear areas it was found that the peacetime systems they operated and the desperate staff shortages from which they suffered made it impossible for them to achieve results as quickly as operations demanded. It is to the great credit of the individual members of MPBW on the ground in Borneo that they achieved what they did.

For more than two years the demarcation between MPBW and RE responsibility was indistinct and field squadrons carried out camp construction and maintenance tasks, using Army money freely, wherever these were reasonable and necessary.

In particular two major new camp-construction tasks each for a battalion headquarters and one company were required in areas on air supply only. These were carried out by field troops from 67 and 69 Gurkha Independent Field Squadrons, using jungle timber and CGI brought in by air, and took a total of twelve troop months.

When things became settled it was possible to work out a system of operations which involved the minimum of waste of military engineer effort on what was properly MPBW work and the correct charging of work to the MPBW vote. The key to the problem was the establishment of 522 STRE (Construction) which rose like a phoenix from the ashes of the Brunei Works Section and in April 1966 came under the direct control of the CRE. The individuals were allotted to the field squadrons to act as the specialist cells in their areas, while the OC remained in Labuan as SO2 (Works) or DCRE as he was actually known. Thus each squadron commander had a powerful team of specialists and advisers on all construction and E and M problems.

The CRE and Area Officer between them divided the country up, military engineers accepting responsibility for those areas in which MPBW were unable to operate. Within those areas squadron commanders were given identical powers of the MPBW superintendents and were allotted necessary funds for maintenance. To all intents and purposes this simply gave the Area Officer a duplicate set of depot superintendents, but with procedures greatly modified to suit working in forward areas.

CONCLUSIONS

Tradition demands a conclusions paragraph with a summary of lessons learnt. In fact, there were few new lessons and those that did emerge will be apparent from the preceding paragraphs. The main point is that there will be a tendency to think of Borneo as the last of this intervention type of campaign that the British Army is likely to fight and that the lessons are of academic interest only. In fact, our defence commitments to Malaysia still exist and who can say with certainty that we will never again be involved in this type of conflict? Whatever the nature of any future emergency, there will evidently continue to be a need to convince commanders and their staffs of the need to have an adequate force level of Sappers, centralized advice and control in the Force Headquarters and a proper Sapper-controlled works, park and resources organization from the very start.

TABLE 1

AIRSTRIPS BUILT OR IMPROVED

	Task	*Dates*	*Unit*
A	Long Seridan	Jan–May 63	69 Gurkha Indep Fd Sqn
B	Long Pa Sia	Feb–June 64 Nov 65–Sept 66	69 and 67 Gurkha Indep Fd Sqn
C	Semporna	Feb–Mar 64	1 Sqn Malaysian Engrs
D	Kuamut	June–Sept 64	7 Fd Sqn RAE
E	Long Akah	Aug 64–Mar 65	69 Gurkha Indep Fd Sqn
F	Kapit	Apr 64–Sept 64	68 and 69 Gurkha Indep Fd Sqn
G	Long Banga	June–Oct 65	69 Gurkha Indep Fd Sqn
H	Meligan	Mar–Nov 65	69 Gurkha Indep Fd Sqn
I	Muara	Oct–Nov 64	69 Gurkha Indep Fd Sqn
J	Lundu	Feb–May 65	3 Sqn Malaysian Engrs
K	Bau	Jan–Oct 65	Tp 11 Indep Fd Sqn
L	Balai Ringin	Jan–Oct 65	3 Sqn Malaysian Engrs
M	Sook	Apr 65	1 Fd Sqn Gp RAE
N	Pandewan	Sept 65	24 Constr Sqn Gp RAE

TABLE 2

ROADS

	Task	*Dates*	*Length (miles)*	*Units involved*
1	Bau–Stass	Jan 64–July 66	10½	1, 2, 3 and 4 Sqn Malaysian Engrs Tp 11 Indep Fd Sqn
2	Bokah–Spur	Feb 66–Sept 66	1¼	32 Fd Sqn and 68 Gurkha Indep Fd Sqn
3	Doyoh–Serikin	Feb 65–Oct 65	5	68 Gurkha Indep Fd Sqn
4	Tebedu–Tebakang	Apr 64	9	68 Gurkha Indep Fd Sqn 1, 2, 3 and 4 Sqns Malaysian Engrs
5	Tebedu–Tepoi	Feb 65–July 65	3	68 Gurkha Indep Fd Sqn 32 Fd Sqn
6	Kenigau–Sepulot	June 64–Nov 66	60	1 and 7 Fd Sqn Gps RAE 21, 22 and 24 Constr Sqn Gps RAE
7	Tawau–Semporna	Feb 65–Dec 65	5¼	1, 2 and 3 Sqns, Malaysian Engrs
8	Umas Umas–Brantian	Feb 66		3 and 4 Sqn Malaysian Engrs
9	Kampong Tiku	June–July 66	1¼	3 Sqn Malaysian Engrs

TABLE 3

C'SRE AND ENGINEER UNITS WHO TOOK PART IN BORNEO OPERATIONS

1 *CRE*		
Lt-Col L. G. S. Thomas, OBE, RE	Jan–Feb 63	
Lt-Col H. W. H.Webb-Bowen, RE	Jan–June 64	
Lt-Col J. F. Allen, MBE, RE	June 64–May 65	
Lt-Col A. E. Arnold, OBE, RE	May 65–June 66	
Lt-Col P. F. Aylwin-Foster, RE	June–Nov 66	
OCRE		
Maj D. J. N. Genet, RE	Dec–Mar 63	
Maj G. N. Ritchie, RE	Mar–Oct 63	
2 *UNITS*		
Unit	*Dates*	*OC*
67 Gurkha Indep Fd Sqn	Jan 66	Maj G. G. Roach, RE
		Maj R. A. S. Ricketts
68 Gurkha Indep Fd Sqn	Dec 63–June 64	Maj D. H. Bowen, MBE, RE
	Dec 64–Aug 65	
	May 66–Oct 66	Maj P. P. Rich, RE
69 Gurkha Indep Fd Sqn	Dec 62–Mar 63	Maj R. J. Francis, RE
	Mar 63–Oct 63	Maj G. N. Ritchie, RE
	Sept 63–Dec 63	
	July 64–Jan 66	Maj R. D. P. Brown, MBE, RE
32 Fd Sqn RE	Aug 65–May 66	Maj A. G. Steel, RE
11 Indep Fd Sqn	(Tp) Apr–Sept 63	
	(Tp) Jan–May 65	Maj J. H. G. Stevens, RE
Tp 9 Indep Para Sqn	Jan–May 65	Lt A. J. Wright, RE
1 Sqn Malaysian Engrs	(Tp) Sept 63–Aug 65	Maj K. K. Khong, ME
	Jan 66–Sept 66	Maj J. B. Lopez, ME
2 Sqn Malaysian Engrs	Sept 63–Dec 64	Maj N. Selverajah, AMN, ME
	Aug 65–Feb 66	
3 Sqn Malaysian Engrs	Dec 64–May 65	Maj G. G. Carter, MBE, RE
		Maj D. O. Caton, RE
4 Sqn Malaysian Engrs	May 65–Dec 65	Maj J. M. Duck, RE
	Sept 66–?	
1 Fd Sqn RAE	May 64–Dec 64	Maj F. Cross, RAE
7 Fd Sqn RAE	Dec 64–May 65	Maj R. L. Paramor, RAE
24 Constr Sqn Gp RAE	May 65–Dec 65	Maj M. Johnston, RAE
21 Constr Sqn Gp RAE	Dec 65–May 66	Maj J. N. Stein, RAE
22 Constr Sqn Gp RAE	May 66–Dec 66	Maj P. I. Pell, RAE
54 Corps Fd Park Sqn	(Det) Dec 62–Apr 63	Maj D. J. N. Genet, RE
	(Det) Dec 65–Dec 66	Maj H. W. Mackintosh, RE
Brunei Works Section and	Dec 62–July 66	Maj D. E. Townsend-Rose, RE
522 STRE (Constr)		Maj H. F. MacSwiney, RE
		Maj T. W. Tinsley, RE

Water Supply Improvements at Hiron, Wadi Aidam, Dhofar Province, Oman, August 1967

LIEUTENANT S. LANE-JONES, RE

BACKGROUND

THE writer is a degree student at the Royal Military College of Science, Shrivenham.

During the summer vacation students are encouraged to organize and take part in some form of adventure training. Two RE officers, Lieutenant S. Lane-Jones and Lieutenant R. H. Smitherman, had been on a visit to Pakistan and were in Bahrein awaiting an RAF indulgence passage back to UK, when the request for a Sapper officer to go to Muscat was received by CLFG. As there was a shortage of RE officers in Bahrein Lieutenant Lane-Jones was aked if he would undertake the task.

This report was submitted to CLFG by Lieutenant Lane-Jones on his return to Bahrein.

INTRODUCTION

The Sultan's Armed Forces (SAF) in Dhofar are faced with the problem of preventing anti-Sultan rebels infiltrating from Eastern Aden Protectorate (EAP) and Saudi Arabia into Dhofar. Most of the rebels and their supplies are moved in by camel and are, therefore, confined to known camel tracks. At present the Muscat Regiment (MR) is stationed at Salalah and has one company located in the field at Janook about seventy miles west of Salalah. The company maintains ambushes whose task is to block two camel tracks which are known to be likely rebel routes.

Water supply to the company at Janook has been a serious problem, the nearest usable source of water being a series of large rain pools in a deep wadi (Wadi Aidam) at Hiron, about fifteen miles north of Janook. It is estimated that the largest of these pools will last for one year if there is no further rainfall.

There is a usable vehicle track from Janook to Hiron which enables vehicles to get to the top of the wadi and about three-quarters of a mile from the water. Previously water has been carried in jerry-cans from the pool to the vehicles and it has taken a platoon of about thirty men a day to get sufficient water to last the company for two days.

In response to a request by Brigadier Purdon, Commander SAF, to Brigadier I.R.R. Hollyer, Commander Land Forces Gulf, for a Sapper officer to advise and help with improving the situation, I was asked by CLFG to go to Salalah to be at the disposal of MR to give whatever help I could. My task was to visit the site at Hiron and devise some method of speeding up the process of getting water from the wadi to the vehicles, in order to cut down the time taken and number of troops used to maintain a sufficient supply of water to the company position. This was at first thought to be a road-building task.

MOVE TO JANOOK

I left Bahrein for Salalah by RAF Argosy at 1100 hrs on 7 August after having obtained the necessary visas for Muscat and Oman. On arrival at Salalah I was met by an SAF officer and taken to HQ MR camp at Salalah. The CO, Lieut-Colonel Alexander, gave me a quick briefing on the situation in Dhofar and on the job to be done. At this stage I still had little idea of the size of the task or site conditions, but it appeared that resources were limited to what I could find myself. I was quickly equipped with a camp bed, two blankets, a rifle and a shemag and put on a Beaver of SOAF *en route* for B Company position at Janook.

On arrival I was met by the company 2IC (Captain Murray, RM), who was temporarily in command. He had done a Field Engineering course at the RSME, Chatham and had had some field-engineer experience mainly in the use of explosives. His plan was that we should visit the site together the next day, 8 August, to carry out a preliminary recce.

That evening the meal consisted of goat meat and rice, very hotly curried, and I was assured that this was the only diet.

RECCE OF SITE AT WADI AIDAM

We set off at 0730 hrs and arrived at Hiron at about 0815 hrs. The road was little more than a track across the desert on which no work had been done. It was, however, easily passable to the Land-Rovers and 3-tonners with which SAF are equipped.

On arrival the magnitude of the task became apparent and I immediately realized that there were two tasks, not one, due to the shape of the ground. The existing route into the wadi was along a spur between two smaller wadis at right-angles to Wadi Aidam. From the end of the road there was a drop of about 150 ft down an extremely steep slope on to the top of a spur, which was fairly flat and level for about 600 yds. At the end of the spur was another steep drop of about 200 ft to the water pool. Originally a camel track had existed down both slopes. This had been improved to a certain extent in order to get Land-Rovers half-way down the second slope. The track surface was constructed of uncompacted large round stones on a steep gradient. Great difficulty was experienced in getting the Land-Rover back up the slopes, even when unloaded, so that it could only be used to carry jerry-cans across the flat top of the spur.

From this recce it seemed that it would be possible to improve the surface of the top track sufficiently to make it passable to loaded Land-Rovers. The lower slope was extremely steep and there appeared to be little chance of making a passable track down it without a great deal of labour and plant which was not available.

RESOURCES AVAILABLE

At first it seemed that the only resources available were four pickaxes, four shovels, two crowbars and two sledgehammers. After some discussion with Captain Murray, I learned that there was an American oil company camp at Midway, on the route from Salalah to Janook. As this was being evacuated in the near future, there might well be some stores available there. SAF could provide up to 50 lb of PE 808 and a platoon of about thirty soldiers from the company at one time. SAF also had on call a platoon of donkey-handlers with donkeys and a pioneer platoon. These were stationed at Muscat and would take some time to move to Hiron. Captain Murray was not sure whether they were available or not. There was also the chance that Defence Department at Salalah or RAF Salalah might have some stores available, but these would have to be begged or stolen.

PLAN

From site conditions and the probable availability of stores and labour I arrived at two possible plans for the top route.

(*a*) To re-align completely the track on the top slope in order to reduce its gradient and make it passable for 3-ton trucks, including the water truck. This I estimated would require about three weeks' work using the platoon from the company, plus a platoon of donkey-men and pioneers with hand tools and donkeys, and about 400 lb of PE 808 for rock blasting.

(*b*) To improve the existing track on the top slope to make it passable to loaded Land-Rovers, by using the existing alignment and reducing gradients and resurfacing where necessary.

This I estimated would take thirty men about three days using tools held at Janook and about 20 lb PE 808. Surfacing to be, initially, with local stone and later finished

with some trackway expedient if this could be found. (I was thinking of square mesh, PSP, or XPM at this stage.)

On the lower slope Captain Murray suggested an aerial rope-way, but did not know if it was feasible. I thought it was, and I planned to build on the assumption that I would be able to find sufficient stores to improvise. This was to consist of a gyn at the top, with a cable span of about 400 ft, and the lower anchorage to be to a large boulder in the wadi bottom. The rope-way was to be powered by a Land-Rover driving backwards and forwards across the flat-topped spur. This would enable water to be drawn up in Jerry-cans to a point where they could be loaded on to a Land-Rover, which would then drive to the top, where they could be emptied into the 3-ton water truck.

These two plans were sent by radio to CO MR on the evening of 8 August for his approval. He quickly decided in favour of plan (*b*), as he could not guarantee the availability of pioneers and donkey men, who would in any case take at least a week to move from Muscat to Hiron. I was to fly back from Janook to Salalah via Midway to search for suitable stores and explain the plan in detail, also to work out some plan for moving stores from Midway to Janook.

ACQUISITION AND MOVEMENT OF STORES

I flew to Midway by Beaver on the afternoon of 9 August. I found an American foreman as the only man at the camp, which was guarded by a platoon of MR. The foreman said I could take away anything from his scrap dump, but nothing from inside the camp. The dump contained nothing of any use except a large quantity of drilling pipe in various diameters, but I found large quantities of useful stores inside the camp which I earmarked for future use if I could persuade someone to let me have them. I did, in fact, manage to beg 12 x 25 yd rolls of chain-link fencing, which I planned to use instead of Sommerfeld track for the road surface, and 15,000 ft of $\frac{7}{16}$ diam SWR for the rope-way. This was strewn over a large area and I asked the guard commander, a SAF Arab officer, if he would start winding it on to a spool which was near by.

Having found these stores, I flew to Salalah at 1600 hrs.

On 10 August I made contact with the Defence Department site manager of the new camp at Salalah, who turned out to be an ex-RE corporal now working for Wimpeys and on loan to Defence Department. He had a wealth of knowledge and some RESPBs. He promised to make me a suitable platform to carry five jerry-cans, which we calculated as the maximum safe load. He also gave me a double-sheaf pulley block and lent me two Pul-Lift jacks for tensioning the cable.

On a walk around the camp looking for more stores I found two Sapper plant operators working on a very antiquated D8 dozer belonging to the oil company. It turned out that they two had been loaned from 10 Field Squadron to SAF to doze an earth dam across the back of the camp to prevent flooding. Their dozer had broken down and, as they were doing a wonderful job of improvisation in repairing the CCU, I was able to give them some help and advice. I had the idea that they could be very useful to me at Janook and they volunteered to come up and help if I could persuade CO MR to release them after they had finished their dam.

That evening I saw Lieut-Colonel Alexander again and explained my plan in detail. I asked him if he could get permission for me to remove the stores I needed from Midway. This he promised to do, but he was extremely busy with his hand-over and a visit from Commander SAF and could offer little further help. He did tell me that A Company was leaving Salalah by convoy the next morning to replace B Company at Janook. The convoy would be spending the next night at Midway, and although there was no extra transport available I was welcome to fill any spare space which I could find on the 3-tonners. We agreed that I should spend the next morning doing a recce of another oil company dump at Rizuit, about eight miles from Salalah, to try to find some extra stores for road improvement, expecially beach roadway pickets or some substitute. I was to fly to Midway to join the convoy and load stores the next

afternoon. He also gave permission for the two sappers to join me at Janook for a few days, when they had finished the dam. My trip the next morning did not bring to light any further stores, but I saw sufficient quantities of angle iron to make up about 200 pickets if someone could be persuaded to cut them up at a later date.

That afternoon I flew to Midway and met A Company convoy. I was pleased to find that the guard had rolled up a large quantity of SWR and it was almost ready for loading. The stores which I had selected were quickly loaded on to a 3-tonner which was the only vehicle available. It was also carrying twenty goats, which were rations for the company for several weeks! As I had not been able to find any pickets for anchoring the chain-link fencing, I decided to concentrate on moving all the rope-way stores and leave the fencing to be brought up on a future convoy, as a separate 3-tonner would be required to move it.

We spent the night at Midway in air-conditioned caravans and fed on American canned food. We left at 0700 hrs next day, 12 August. That day we drove mostly across open desert along the southern edge of the Empty Quarter to a spring system at Mudai. We were plagued with minor breakdowns, punctures and boiling radiators, in the intense dry heat up to 125°F at midday.

On 13 August we drove into more mountainous country as we approached Janook. The route was extremely rough and many times vehicles had almost to be carried up steep wadi sides which I would have believed impassable to anything but goats. Luckily the threat of enemy attack was small and we did not have to picket every hilltop along the route. Eventually we arrived at Janook at about 1430 hrs after nine and a half hours' driving, to the delight of B Company, who immediately loaded up and left on their return journey to Salalah and civilization after five weeks on patrol under constant threat of attack by the Adu.

On arrival I was delighted, but somewhat puzzled, to find that the two sappers had arrived by air that morning with very little kit, no bedding, and very little idea of what they were supposed to be doing. I had agreed to signal when I wanted them but luckily someone at Salalah had prevented any delay be sending them off to meet me. We soon made them comfortable in a tent of their own with my blankets, as I had a bed and a sheet. They were immediately treated as sahibs and waited on hand, foot and finger. They even managed to eat very hot curried goat and rice and apparently enjoyed it. They soon got on well with the Arab soldiers and were invited to share tea and conversation well into the night.

The next morning, 14 August, we left at 0630 hrs for Hiron with the company 2IC and twenty-four soldiers. I planned to let the two sappers build the rope-way whilst I supervised overall, but with my main attentions directed to road improvement.

WORK ON THE SITE

The first problem occurred on arrival, when we discovered that the rough journey had caused the centre of the spool of SWR to collapse, trapping the cable so that it could not be unwound. Eventually we had to take one end off the drum and uncoil it, which produced enormous twists which had to be carefully taken out.

All the stores, including the three 20 ft 3½ in. diam pipes for the gyn, were carried down to the site of the rope-way and the SWR was pulled down by hand. The working force was considerably reduced by the necessity of providing sentries, also the discovery that the CQMS had loaded breakfast on to the wrong 3-tonner and a party had to be sent back to Janook to collect it.

I took the two sappers to the gyn site and carefully briefed them on how to lash and erect it. I left them with eight soldiers, who were to work when required, and who were also to fill and carry jerry-cans to the top of the slope.

I now discovered that during the journey one of the precious snatch-blocks, together with a 100 ft steel tape which I borrowed from Midway, had been lost or more likely stolen. This posed a considerable problem, as I was not sure where to find a replacement for it, although I had been promised one by Defence Department foreman at Salalah; he could not find it and thought it had been stolen, but would

make efforts to ensure its return. This meant that we would not be able to erect the cable until another snatch block was located, in case the replacement should be of the "non-gated" pattern. During the day we succeeded in lashing the gyn and moving the standing cable into position on the ground, attaching it to the lower anchorage, which was a very large boulder in the wadi close to the water-hole. I arrived on site to find that the Arabs had devised some fantastic anchorage of their own to the wrong boulder, using all the available cable clips and dropping a few into the water. It took me about an hour to get this sorted out.

We also started to dig a trench for the ground anchor (I had brought a large piece of pipe about 6 ft long to use for this) at the top of the slope above the gyn. I had managed to make a start on improving the top track, by repacking the large stones to make a smoother surface and compacting with rubble which was excavated close to the track. I also did some successful stone blasting to remove a rock shelf which was jutting into the track and making it impossible to reduce the gradient. The soldiers were very fit and strong and enjoyed the work, which was a novelty, and which they realized was going to ease their burden when it was completed. They were fascinated by the rope-way and very excited by the blasting.

By now I had discovered quite a lot about handling Arab labour and had learnt a few necessary words of Arabic. The soldiers cannot be hurried and require several breaks during the day. One for breakfast from 0900 hrs until 1000 hrs and another for tea at about 1300 hrs. Work stopped at 1530 hrs to allow time for a wash in the water-hole before returning to Janook for the evening meal of the inevitable goat and rice before nightfall.

In the evening I sent a signal to Salalah requesting that a snatch block be flown up and para-dropped on to site the next day. This was agreed, as the missing block at Salalah had been found. That night I went to bed extremely tired and with very large blisters on my hands. I had developed a bad cold during my stay in Salalah and was not feeling well, so could not get much sleep.

The two sappers, who were by now being referred to as "the two Sapper sergeants", were thoroughly enjoying themselves and were much happier as some blankets had been flown in for them. They had done an excellent day's work.

On 15 August we left again at 0630 hrs, ensuring this time that breakfast was taken with us. The plan for the day was to continue with road improvement as quickly as possible, to complete the anchorage for the gyn and to tension the cable as soon as the gyn was erected and the snatch block delivered. The morning started with a bang as I blasted out the last of the rock in the road surface. The road improvements went very well, as the soldiers had grasped what was required of them and we sent 3-tonners off to collect extra aggregate for compacting the surface.

The gyn was erected and the anchorage completed by 1400 hrs, but we were then held up waiting for the snatch block to arrive so that we could begin tensioning the main cable.

The Company Commander arrived in mid-afternoon to see how work was progressing. He trusted our improved track sufficiently to drive down it to the gyn site. On his way back with a full load of water he broke a half shaft and all hands were required to manhandle the Land-Rover to level ground so that fitters could begin work on changing the axle. He brought news that the snatch block was not arriving that day, so we spent the remainder of the afternoon filling and carrying jerry-cans before washing and returning to Janook. On my return to Janook I was told that I was to return to Salalah the next morning, as OC 10th Field Squadron had demanded the return of his two sappers, and I would have to leave in order to catch my flight to Bahrein on 17 August, as the Beaver had to go in for servicing. This news was annoying for everyone, as we thought that one day's work would complete the rope-way. However, this was the only way we could be got out in time, so we had to accept that someone else would have to finish the task.

I spent the evening carefully explaining the process of erecting and tensioning the cable to the company 2IC, who would probably have to complete it.

In the morning we packed up our kit and left Janook at 1030 hrs after final explanations and farewells. On arrival at Salalah I wrote to Major Hutchins, OC 10th Field Squadron, commending the excellent work of the two sappers and then went to see why the snatch block and platform had not arrived. It appeared that this was due to a lack of liaison between SAF and Defence Department, as the block had been waiting for three days.

The CO was again extremely busy, as GOC MELF was visiting the next day. He thanked me for my help and for writing to Major Hutchins and assured me that the work would be finished as soon as possible. I spent the rest of the day visiting and thanking everyone who had helped me with the task.

I left for Bahrein at 1340 hrs on 17 August.

CONCLUSION

This was a most interesting and enjoyable trip for me and provided valuable experience in performing a useful task under adverse conditions with few resources and little actual help. I had the impression that this job was hardly scratching the surface of the engineer effort which is needed in Dhofar. Track construction and maintenance is becoming a very high priority as the oil company evacuates, as they have maintained only a few tracks for their own use for several years.

SAF operates on a shoestring and has little time or effort to spend on non-essential tasks. They are apparently being successful in containing rebel activity, as no contacts had been made for some weeks.

I am sure that the necessary knowledge to do all the work which I did already existed in MR. I felt that my presence did, however, provide motivation to get the job moving by finding and transporting a few vital stores to the right place at the right time. As one person explained to me before I left, "A Sapper cap badge works wonders, because no one is prepared to set Sapper work in progress on the advice of a non-Sapper, however simple the work may be!"

Submarine Sappers

A/CAPTAIN J. D. BRAITHWAITE, RE

In 1825 the first experiments in firing explosives under water were carried out at the Royal Engineer Establishment, Chatham (now the Royal School of Military Engineering), and between 1835 and 1843 several wrecks were removed from navigation channels, the most notable being HMS *Royal George*, sunk at Spithead. Diving became a recognized Corps trade and it has remained so to this day, even though over the years the number of divers employed in the Corps has fluctuated considerably.

Today diving is coming back into general use in the Corps, and it is hoped that this short article will be of interest to all Sapper officers, particularly those with divers in their units.

There are many hazards involved in diving which can prevent a diver from carrying out the tasks given him. There are several medical dangers, there is the risk of being trapped underwater and there are the psychological deterrents of having to work in cold, dark water, possibly with water leaking into the breathing tube. Consequently, a diver must be of a very high physical standard. He must train constantly, both above and below water. He needs constant medical tests, and must work to stringent safety regulations.

For these reasons, the only completely effective diver is the professional and this is true in any specialized trade. A professional diver has the time to develop and practise his techniques, and thoroughly to maintain his equipment, so that he is always ready if required for a job of work. Professional teams in the Army could be organized on a basis of one per theatre and if organized in this way, much of the time and expense put into diving at the present time could be avoided. However, the trade structure in the Corps, and the present hostility towards the specialist on the grounds of adaptability, prevents the adoption of truly professional divers. So we must direct our thoughts towards the concept of the Unit Diving Team.

Diving to the Sappers is like a truck to a field section; it is a means of getting on to a task. The better a diver is trained, the quicker he can complete his task. Some typical tasks are:

Mine and obstacle laying and clearing.

Repair and maintenance of RE floating bridge equipment and RCT harbour equipment *in situ*.

Recovery of sunken AFV.

River-bottom profiling and reconnaissance.

Assistance in underwater construction tasks such as concreting, welding and cutting steel and placing and inspecting grillages and piles.

Underwater demolition of locks, harbours and inland waterway installations.

Hydrographic surveys.

Searches for lost training stores at bridge sites and evidence for the police in IS work.

Training tank crews in submarine escape routines.

Advice to unit commanders on prevention of enemy diver penetration and other aspects of underwater warfare.

Perhaps surprisingly, many people want to have a finger in the Diving Pie in spite of the inconvenience and hazards involved. Perhaps they visualize the possibility of glamorous Adventure Training in the Mediterranean with SCUBA in one hand and a fair maiden in the other. But who really needs divers for their work? There is a weak case for the Tank Corps, who need qualified instructors for submarine escape drills, though the best unit to do this would be the RE Diving School, perhaps with a sub-unit at Bovington. The REME have a good case for the recovery mechanic to be a diver because of the requirement for him in sunken AFV recovery. However, because eight out of ten of the diver's uses are Sapper tasks anyway, it has been

established in the Army that diving shall remain a Royal Engineer responsibility.

What is the best type of unit to have a diving team? I believe that the level of the major unit is the most suitable, with its field park to provide the extra stores that a team sometimes needs, such as watermanship equipment, and with its LAD from which can be drawn a diving recovery mechanic to assist the team when necessary.

Now that so much specialized equipment is arriving in units, and many personnel are being trained in diving, giving the already perhaps overtaxed unit commander yet another trying headache, many are wondering what to do with a diving team.

One CO solved the problem by putting all the divers and their equipment into one troop, whose troop commander or SNCO was a diver and suitable as a unit supervisor. Another put the equipment into the field park squadron, with a full-time diver-storeman, drawing divers from field units as and when necessary. A third had all his divers and the kit transferred to the field park. There were even cases of the kit being put into the local sub-aqua store and the divers encouraged to join the Club!

All these methods have advantages and disadvantages, but the one that seemed to work best was the first because, being in one sub-unit, the divers were easily available for specialist training and any task required of them.

The ideal unit diving team might be composed of the following personnel:

A supervisor, namely a qualified diver and diving supervisor, preferably an Officer or SNCO.

Two "advanced divers", qualified combat engineer divers with plenty of experience.

Two basic divers.

A driver RE BIII diving storeman, a qualified basic diver.

In the team, one of the advanced divers should be a qualified underwater welder, a task which is far removed from surface welding and needs much practice to perfect, and another member should be a REME recovery mechanic drawn from the unit LAD. This structure allows for:

A supervisor and standby diver.

Two working divers with two attendants.

A permanent storeman.

A team for REME work without having to form a separate REME team.

A breakdown in dire emergency of three buddy-pairs for individual tasks. Other divers in the unit should be kept "in date" by the supervisor, to keep a reserve of divers for large tasks, or for replacing team members who are sick or on leave.

The team's stores divide into two categories:

G1098 or watermanship stores which must be obtained for each task from squadron or field park resources, and

Diver specialist stores which include the following:

6 sets of divers equipment and the diving compressor.

Seafire underwater cutting torch with hydrogen and oxygen gas cylinders.

Cox bolt-firing and punching gun with its ammunition.

Underwater watches, compasses, depth gauges, torches, etc.

Cordage, repair kits, small stores, spare parts (of which there are hundreds).

These specialist stores must be kept in trim by the divers themselves, and must be stored in such a way that they are always quickly available to the team if they are called out on an emergency task.

At present no transport is issued for the divers' permanent use. The ideal transport, however, would be a 3-ton truck with a container mounted in it, and a one-ton trailer. The truck would act as a changing room and drying room for the team on site, and would carry the small items. It would also be a mobile workshop for on-site repairs to be carried out when necessary and it should be adequately ventilated to enable the team to travel to a task in it without calling for extra transport. In the trailer would be fitted the diving compressor, capable of charging bottles while the team was on the move between sites, and the Seafire equipment.

The advantages of a team based in this truck-trailer combination would be as follows:

No diving store would be necessary in barracks, as the equipment would be secure in the truck.

The kit would be permanently loaded, making the divers immediately ready at any time for an emergency call.

The driver-storeman would be adequately employed maintaining his truck and the diving equipment as a full-time task.

The team would have a permanent mobile base from which to work.

This system for the unit diving team has been tried in the field and proved to be effective and it is easily within the scope of any major unit to organize such a team. A photograph of such a team is shown in Photo 1.

All divers must receive continuous underwater training, or they may develop a fear of the water and become unfit to dive. Three hours every two months is the minimum allowed to keep his qualification without being re-tested. This amounts to about one day a fortnight on diving work. To help in this, a good supervisor can instil a sense of keenness into the divers of his team such that they try to get in as much diving experience in their spare time as possible.

It is not the role of the RE diver to engage in clandestine operations. There are other units in existence with the right equipment and training to do this type of work. However, the Sapper diver may be called upon to work in forward areas and unit commanders should know their limitations. The main problems are, firstly, the loud noise the kit makes when the diver takes a breath on the surface and, secondly, the great weight of the kit which must be carried to the work site.

However, there is the possibility of using divers as "surface swimmers" without their breathing equipment. A team can swim many miles without getting cold or tired, and can tow a recce boat full of equipment. If the boat is deflated, until it only just floats, the team becomes almost invisible at night and is completely silent.

I hope that this article has shown how a unit diving team can best be organized and employed.

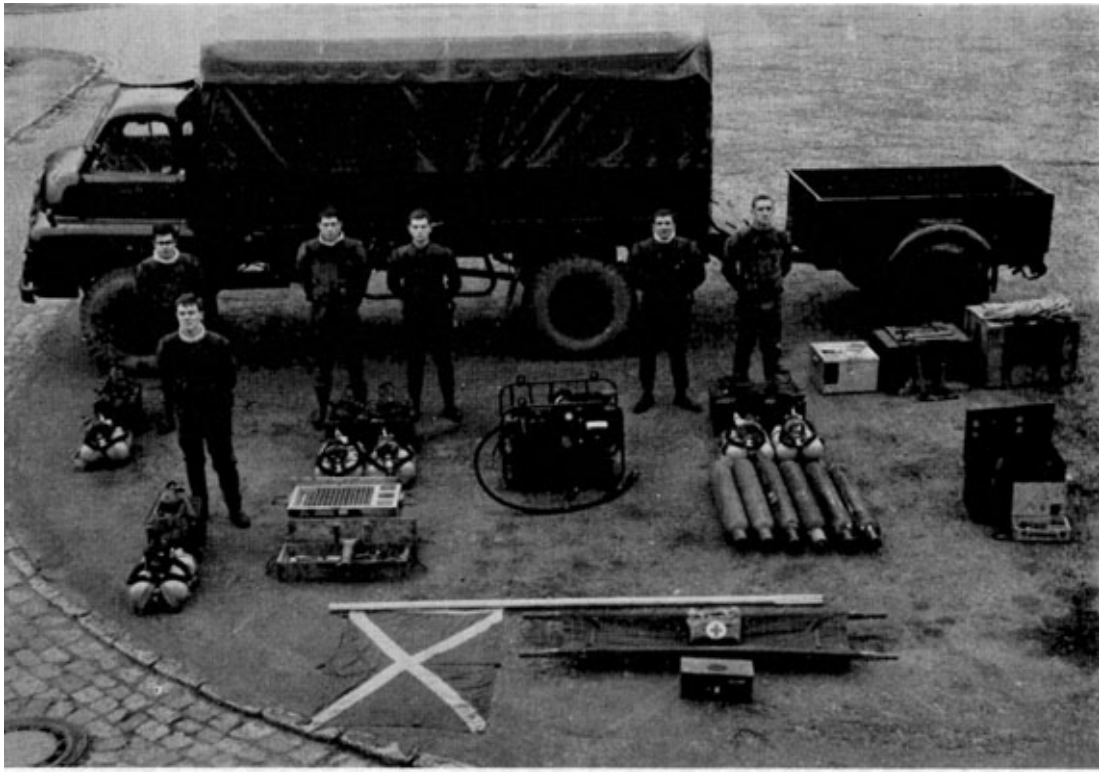


Photo 1. Suggested Diving Team.

Submarine Sappers

Far Eastern Outpost

LIEUT-COLONEL R. S. HAWKINS, RE (Retd), MA, AMIMechE

LORD PALMERSTON was very angry. "You have disobeyed and neglected your instructions" he wrote. "You were instructed to demand full compensation for the opium, which you took upon you two years ago to deliver up. You have accepted a sum much smaller than the amount due to the opium holders. You were told to demand payment of the expenses of the expedition, and the payment of Hong debts. You were told to retain Chusan until the whole of the pecuniary compensation should be paid. You have obtained the cession of Hong Kong, a barren Island with hardly a house on it; it will never be a Mart of Trade, any more than Macao is. You still have failed in obtaining an additional opening for our trade to the Northward. Under these circumstances it is impossible that you should continue to hold your appointment in China."

The date was 21 April 1841, and the target for the Foreign Secretary's invective was Captain Charles Elliot, RN, Chief Superintendent of Trade and HM Plenipotentiary for the British merchants trading with China. The much-maligned Elliot had been in an impossible position; normal commercial relations with the Chinese were non-existent, and all dealing, by edict of the Emperor of China, Son of Heaven, had to be carried on at Canton between the Hong merchants (official brokers) and the "barbarians" (non-Chinese). The trade in "foreign mud" (opium) was forbidden, but nevertheless, this produce of India was a major import, delivered in British ships as contraband to Chinese dealers on the Eastern Coast, to the immense financial benefit of mandarins and Revenue officials. To stop this trade and the loss of official business, the Chinese Commissioner at Canton demanded the surrender of existing stocks of "foreign mud"; he also closed the port of Canton and prevented the departure of British merchants by duress. In April 1839, Elliot was, in fact, forced to deliver up over 20,000 chests of the merchants' opium, valued at £2,000,000, which was destroyed in lime pits.

This gross insult was finally avenged in January 1841 when a British naval and military force from India took the Bogue forts guarding the river entrance to Canton; shortly afterwards the Treaty of Chuenpee was concluded, which incurred the wrath of Palmerston. In August 1841 Sir Henry Pottinger arrived to replace Elliot, and in the following year a strong British force, under Sir Hugh Gough, battled its way up the China Coast to the gates of Nanking. The Son of Heaven had no option but to conclude the Treaty of Nanking on 29 August 1842, by which the cession of Hong Kong was confirmed and the Treaty Ports of Canton, Amoy, Foochow, Ningpo and Shanghai were opened for normal trade. In addition HM Government received a total indemnity of about £5,000,000. By the Treaty, Hong Kong was regarded only as a port where British subjects might "careen and refit their ships", but, on 5 April 1843, the Privy Council erected the Island of Hong Kong into a Crown Colony, and from this haven British merchandise, including, of course, the forbidden opium, could be imported into China under the shelter of the British flag and, if necessary, the guns of the Royal Navy.

The Board of Ordnance in January 1843 selected Major Edward Aldrich, RE, then stationed at Woolwich, as the first CRE Hong Kong, and asked the Admiralty to arrange a passage for him by the Overland Route. With very little time to spare he asked for a sea passage for his wife, one servant and one ton of baggage for his books and instruments. He also obtained an advance of £100 for that part of the journey that could not be arranged by the Admiralty. On 31 January he started off on his

journey, on the London and South Western Railway from the London terminus at Nine Elms to Southampton.

Prior to 1830 the only practicable route for passengers and mail from England to India and the Far East was by sailing-ship round the Cape of Good Hope. It was then quite impossible for steamships to undertake this long voyage, as they could not carry enough coal. The Overland Route was pioneered by Thomas Waghorn, and by the mid-1830s he had established his own more rapid mail service to India, making use of the Admiralty steam packets operating between Falmouth, Gibraltar and Alexandria. The mail was taken overland from Alexandria via Cairo to Suez, and then onwards by East India Company ships. Waghorn also undertook to transport passengers and their baggage on this overland section. Coal was supplied to Aden by sailing-ship round the Cape, and to Suez by Alexandria, and overland by camel train. In 1840 the Peninsular and Oriental Steam Navigation Company obtained the mail contract between the new rail terminus at Southampton and Alexandria, and, in addition, undertook to provide steamers to operate between Suez and India. The Company later secured control of Waghorn's overland transport company, J. R. Hill & Co., which was eventually bought by the State-controlled Egyptian Transit Company.

Major Aldrich sailed from Southampton on the P & O wooden paddle steamer *Great Liverpool* of 1,311 gross tonnage; her engines used steam at 7 lb per sq in, and delivered 464 horsepower. He reached Alexandria in eighteen days, and then proceeded forty-four miles by steam packet on the Mahmoudieh Canal to Atfeh. Here he transferred to a P & O river steamer, and journeyed a further 120 miles up the Nile to Boulac. He reached Cairo, two miles away, by horse-omnibus and no doubt rested for a while in the Great Eastern Hotel. For the eighty-four mile journey across the desert to Suez, transport was provided by J. R. Hill & Co; Major Aldrich travelled in a two-wheeled carriage "with a cane work body, open sides fitted with curtains, and a double roof, on large-diameter wheels with patent springs and axle". There were eight staging posts or resthouses on this crossing, the flies were awful, and at the central staging post, No 4, he could get a meal and, if he wanted it, a bottle of beer for 1*s* 10*d* or a bottle of Port for 5*s*. The whole crossing from Alexandria to Suez was scheduled to take eighty-eight hours. From Suez there was no regular steamer service provided by the East India Company, so he took a passage on the first available ship to Aden.

Edward Aldrich reported his eventual arrival in writing to Lieut-General Sir Frederick Mulcaster, KCH, Inspector-General of Fortifications:

"I have the honour to report my arrival at Hong Kong on 10th June 1843, and that I have communicated to Lord Saltoun and Sir Henry Pottinger[1] the orders and instructions I have been furnished with.

"I arrived at Bombay in the *Atalanta* Steam Packet vessel from Aden on the 15th March. The mail was forwarded to China in an opium clipper, and the Captain commanding her objected to receiving me as a passenger. I therefore took passage in the first sailing vessel from Bombay for China, the Barque *John Tomkinson*, which sailed on 26th March, and I reached Macao in her on 9th June."

He found that the British merchant community at Hong Kong had already established "factories" (storehouses), dwelling-houses, schools and some churches; the Civil Government had enforced some sort of law and order in the rather unhealthy, pirate-infested Island. There was a British garrison from the Indian Establishment, for whom Indian pay and allowances were in force. Military engineering had been directed by Lieutenant John Ouchterlony, Madras Engineers, and he formally handed over his duties to Major Aldrich, who adopted the title "Commanding Royal and Superintending Engineer". Under the Indian system there were Executive and Assistant Engineers, who were paid extra according to their status and qualification. Ouchterlony shortly left for India, Lieutenant H. W. Hitchens, Madras Engineers,

[1] Maj-Gen Lord Saltoun was Military Commander in China; Sir Henry Pottinger was Governor of Hong Kong, HM Plenipotentiary to the Court of Peking, and Superintendent of Trade.

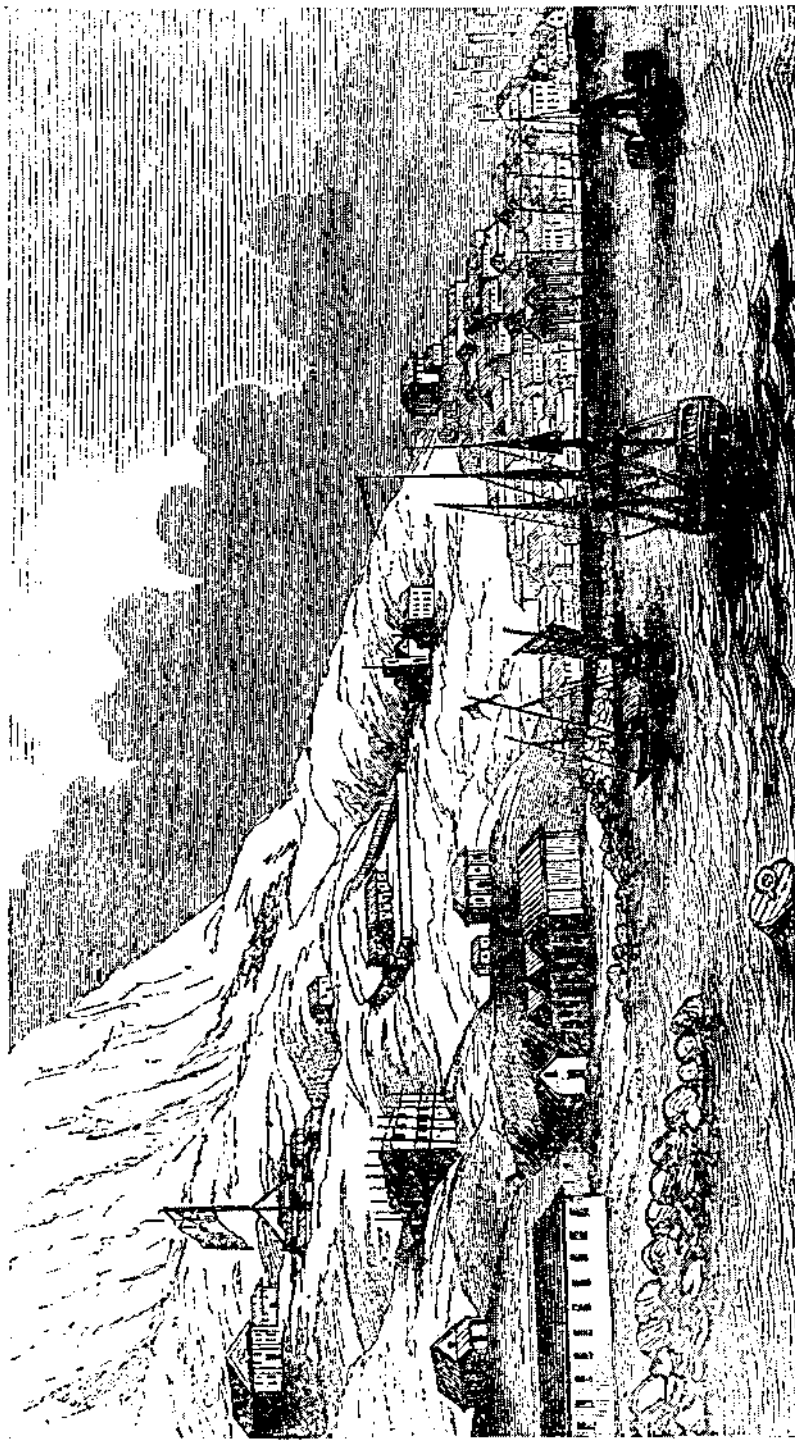


Photo 1. Hong Kong (1842)—by Lieutenant John Ouchterlony, Madras Engineers.

was Executive, while Captain D. Rainier and Lieutenant J. Montresor of 98th Regiment, and Lieutenant Collingwood, Madras Artillery, were Assistant Engineers. At that time for military engineering work there was only a company of Madras Sappers and Miners on the island, but reinforcements for building up a Royal Engineer Department were on their way from England.

The Board of Ordnance, through the IGF, had arranged for the posting to Hong Kong of Lieutenant T. B. Collinson, RE, a detachment of Royal Sappers and Miners, two civilian Clerks of Works and three Foremen of Works. Collinson was earmarked for the survey of the new Colony, and, in accordance with the requirements of his duties was greatly concerned with his surveying instruments. On 3 April 1843 he wrote to Major E. Matson RE, Brigade Major in the IGFs Department on this subject:

"I beg to recommend that the Telescope be 30 inches in length, and the instrument generally of the best construction Mr. Simms can make. I have also to request that the instrument may not be packed up until I have an opportunity of seeing it."

Passage for the Engineer reinforcements had been arranged by the Admiralty on the freightship *Mount Stuart Elphinstone*, a sailing-vessel of 611 tons. She set out from Woolwich for a five-months voyage round the Cape on 24 May 1843, and carried Thomas Collinson, one sergeant and thirty-two rank and file of the RS & M. It was a tragedy that Mrs Aldrich, who was to have sailed on this ship, had died shortly after bidding a temporary farewell to her husband in January. The Clerks and Foremen of Works, accompanied by wives and children, followed later in the sailing vessel *Palmyra*.

John Ouchterlony had erected several barracks for British and Indian troops on the Island in the vicinity of Victoria; these were mostly "mat houses" of bamboo with palm-frond roofs, though some permanent two-storey buildings were under construction (Photo 1). One of Major Aldrich's first tasks was to obtain a sufficiency of Crown Land on which to build permanent barracks and other military buildings, of which a great proportion was required in or near Victoria. There had been no town planning, and all suitable sites in Victoria had been sold by auction to British and Indian trading houses in June 1841, in the days of Captain Elliot. Sir H. Pottinger soon set up a committee to investigate claims regarding "allotted locations of ground, to define the locations already sold, to remove encroachments, and to prevent infringements of Her Majesty's royalties". This was a valiant and essential move to organize the planning of the City as a Colonial capital and garrison town. Major Aldrich, after agreement with Lord Saltoun, submitted his proposals for military land to the Governor; as a result, this circular letter was despatched to several landholders:

"Government House, Victoria.
July 22nd. 1843.

Gentlemen,

I am directed by His Excellency the Governor to acquaint you that a plan has been proposed by Major Aldrich of the Royal Engineers for laying out and fortifying the centre part of the city, by which plan the locations at present in your respective possession, lying between the ravine separating Government Hill from the adjoining one to the Eastward, and the Protestant Burial Ground, will be included within what will be termed "Ordnance Ground", and that it is therefore possible that you will hereafter be called on to restore these locations to Government, being paid for the buildings you have erected, and the expenses you have incurred on them, and being granted other locations in lieu.

Major Aldrich's plan will be referred to England by the mail that leaves this Colony by the AKBAR steamer on the 1st of next month, and the early decision of HM's Government will be solicited regarding it."

The general problem of land allocation was, at the time, bedevilled by the complete lack of accurate ground survey. It was to be another year before a tolerable chain

survey of the area of Victoria was carried out by Lieutenant Collinson, aided by Sappers and Miners.

At the end of 1843 Major-General G. C. d'Aguilar took up the appointment of Lieutenant-Governor and Commander of British troops in China. In June 1844 Sir John Davis replaced Sir Henry Pottinger as Governor and Commander-in-Chief under the Colonial Office, and Superintendent of Trade under the Foreign Office. Major-General d'Aguilar was deeply concerned about the health and living accommodation of the troops under his command. In 1843 the annual death-rate among European troops in Hong Kong was 22 per cent and among Indian troops even higher; mortality was due to fever (malaria) and dysentery. There was no proper water supply nor drainage, and the adverse effect on health of this lack had been greatly aggravated by the enormous influx of civilians, merchants, Chinese traders and garrison troops. Major Aldrich was, therefore, called upon to erect barracks and hospitals in healthy surroundings, and to tackle the general problem of water supply, drainage and hygiene. Good accommodation was required mostly in the vicinity of the City of Victoria, the commercial centre, and in addition a site near Chuk-Chu, later known as Stanley, was chosen for its healthier topography.

The RS & M Detachment was employed in direct charge of coolie labour, undertaking site clearance for new construction, and the drainage of the more pestiferous and insalubrious areas. They also acted as chainmen for Collinson's survey operations. There is no doubt that they were exposed to more health hazards than others, and, in the first six months, their number was reduced by six deaths due to fever, and three men who were sent home on medical grounds. Major-General d'Aguilar in 1844 expressed his official regret at the casualties, and that the men "in their appearance should show the effects of the climate".

Engineer work was concentrated mostly in Hong Kong, but there was some at Chusan and Shanghai, directed by Lieutenant Hitchens. By the end of 1845 Major Aldrich's staff had been increased by Captain E. W. Durnford, Lieutenants A. F. H. da Costa and F. R. Chesney, all RE. This party set out on 3 January 1845 from Southampton on board the P & O Mail Packet, for the journey by the Overland Route, reaching Hong Kong on 13 May. On arrival, Edward Durnford wrote to Major Matson:

"The Peninsular and Oriental Company have entered into contract with the Post Office to convey the Mails from Ceylon to Hong Kong, in connection with their vessels from Suez to Calcutta—commencing 1st August 1845. The vessels for the Calcutta line leave Southampton on the 20th of every month, and it is estimated that the mails arrive at Hong Kong within 60 days on an average, from the day of sailing from Southampton.

"We came out at a very bad time of year, the few vessels sailing from India make such long passages from the lack of wind. We came from Calcutta in the first vessel that sailed, an opium clipper, and certainly not a breath of wind was lost upon her. Still we were 46½ days from Calcutta to Hong Kong,—about the time the mail is from Southampton to Calcutta via Ceylon. Nothing like steam for travelling!"

Captain Durnford's arrival released Lieutenant Hitchens, who returned to India; da Costa and Chesney were duly appointed Executive Engineers and so drew the extra pay in accordance with Indian regulations. At this time the RE Department consisted of:

CRE Major E. Aldrich RE.

Executive Engrs. Capt E. W. Durnford, RE; Lieut T. B. Collinson, RE; Lieut A. F. H. da Costa, RE, and Lieut F. R. Chesney, RE.

Assistant Engrs. Capt D. Rainier, 98th Regt; Lieut T. A. Street, 98th Regt, and Lieut Collingwood, Madras Arty.

A party of three corporals and twelve rank and file, RS & M, sailed from Woolwich on the freight ship *William Shand* on 3 February 1845 and reached Hong Kong five months later. The RS & M detachment, depleted by deaths, then had a

mustered strength of about forty, of whom ten to fifteen at any time were in hospital with fever or dysentery, a proportion common to both European and Indian troops. There were also two Clerks of Works and three Foremen of Works.

Major Aldrich had battled on with Works Services for nearly two years with only three Assistant Engineers, and his Clerks and Foremen of Works. Collinson had been hard at work on the survey of the Island, so the eventual arrival of Edward Durnford and the two RE subalterns must have been most welcome. In that time Major Aldrich organized an RE Department, selected sites, designed buildings and initiated contract procedure for Works Services. There was little precedent for the conditions under which the Department worked; contract documents had to be prepared in English and Chinese, all work had to be estimated and paid for by measurement, as Chinese contractors were quite unused to tendering, and in addition each service, however small, had to be referred to the IGF in the form of a detailed "Report and Estimate". By a covering authority from the Board of Ordnance, all work approved by d'Aguilar could be proceeded with at once; nevertheless for all the work on design, supervision, measurement and costing the CRE's staff was very meagre.

In the early days all detailed design was carried out by Major Aldrich himself. Building materials were locally available bricks, stone, tiles, sand and lime; sawn timber had to be imported by the shipload from Manila, each consignment being a separate Engineer Service for accounting purposes.

Over a period of four years a vast quantity of work was executed, ranging from drains, sewers and water supply to hospitals, barracks, stores and a host of miscellaneous services. A selection of individual items shows the type of work, both major and minor, carried out:

Hospital for 120 men, including two wards for sick women and children.
Barracks for 230 men.
Barracks for 500 Infantry.
Military Prison.
Twenty rooms for Officers' Quarters under one roof, including mess room, etc.
Commissariat Guard House.
A nine-gun battery along the sea wall.
Expense powder magazine.
Reverberating hot-shot furnace.[1]
Seven pump houses.
Quarters for OC troops, including veranda.
Four book presses for the soldiers' library.
Four desks for the additional officers in the RE Department.

This very abridged list excludes general repairs and maintenance, the improvement of the sea wall and considerable new work on drains and sewers. The RE Department also has to supply sentry boxes, leather fire buckets, coals for the RE Office, furniture and store cupboards. It also altered "a carriage, given over to the troops as a present, to receive and to carry two corpses at one time, to provide a Bier for carrying same from landing place to Hearse".

At the time there was no piped water supply; a pump house consisted of a long-handled "village pump", suitably located under a small roofed structure. Stores demanded and obtained from England consisted of ironmongery in general, door furniture, cast-iron ventilators and vast quantities of sheet lead. For the 120-bed hospital there was a strange demand for "4 Water Closets @ £7, 12 Cocks @ 7/- and a Force Pump"; however, according to the drawings, bucket-type privy accommodation was provided on the basis of single-seaters for Officers and three-seaters for the rank and file.

The financial dealings of the RE Department, in payment for Works Services and so on, were somewhat complicated by the existing currency arrangements. In 1842

[1] Lieut R. J. Nelson, RE, had been of the opinion that the next war would be one of "red hot shot and steam vessels" (RE Professional Papers, 1840).

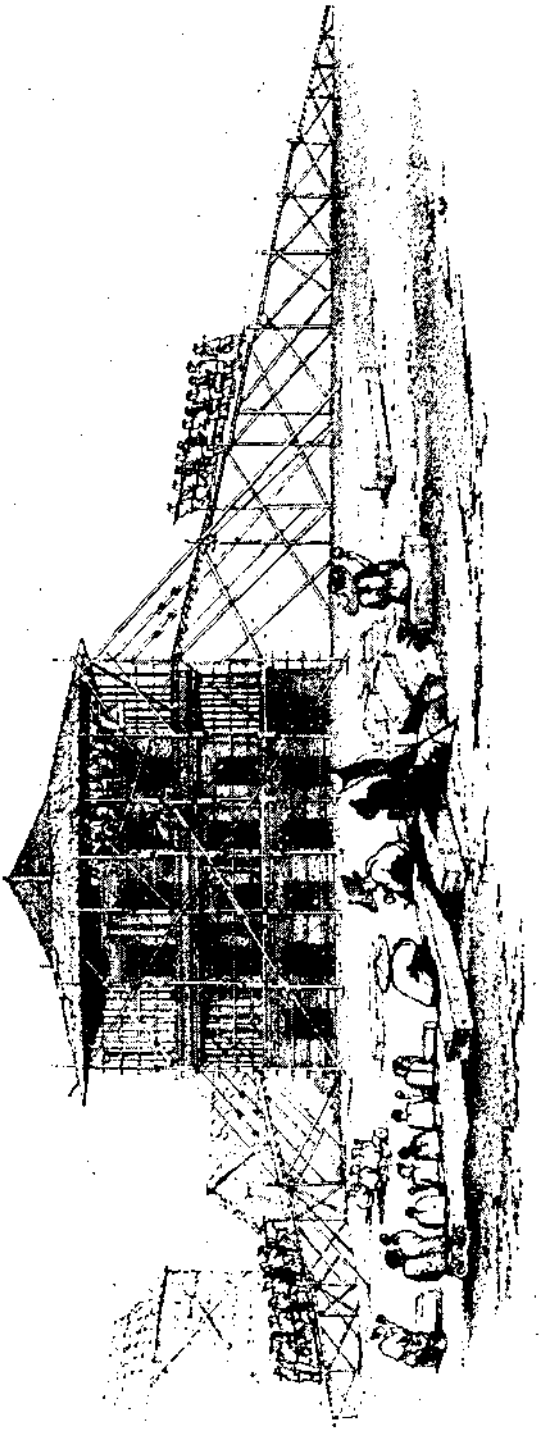


Photo 2. RE Works, Hong Kong (1846)—by Lieutenant T. B. Collinson, R.E.

the standard unit was the Mexican dollar, with an equivalent of 2¼ rupees or 1,200 "cash" (small Chinese copper coin). At first, Engineer estimates were made out in dollars and converted to the £ sterling at the rate of 4*s* 4*d* to the dollar. In 1845 all English coinage and the gold mohur (15 rupees) became legal tender in Hong Kong, but troops were paid in rupees, contractors in dollars, and coolie labour in "cash"!

Major Aldrich received an important assignment for the complete design, report and approximate estimate for a Government House, Government Offices and related buildings at Victoria, and ordered by HE the Governor, Sir J. H. Davis. By an agreement between the Colonial Office and the Military Secretary, "this Colonial Duty was officially placed in the hands of the Commanding Engineer". The design work was completed by 31 August 1845 and was, of course, of the nature of a major project. It was undoubtedly, as stated on the cover sheet, "Designed by Major E. Aldrich RE and drawn by Captain E. W. Durnford RE", as there were no other qualified personnel, such as draughtsmen, to carry it out. The buildings showed excellent architectural taste, and the drawings were completed in great structural detail. Government Offices were not, in fact, finally erected till November 1848, and a new Government House was ready in 1853. Both these buildings followed very closely Major Aldrich's original ideas and plans.

The design of buildings erected by the RE Department of necessity complied with local constructional methods. Thomas Collinson made the sketch (Photo 2) of a typical "Ordnance Building" under construction, and Edward Aldrich gave this descriptive information:

"For the due erection of buildings of any size at this station, it is necessary to provide a mat covering over the whole area, and a little exceeding its dimensions, in order to protect the work from the very heavy rains which fall in summer, and also to protect the workmen from the weather and the powerful influence of the sun. The framework and supports for this covering are made of bamboo, of various heights and thicknesses, fastened together with rattan lashings. Not a nail is used in such a bamboo shed, and, when it is completed, it has an elegant appearance, representing the creditable ingenuity and ant-like labour of the Chinese. They are very ignorant of the value of machinery, and are very averse to its use. It was some time before the use of the devil carriage could be generally introduced, because, when first applied, a Chinaman fell from the shafts, and the wheel, passing over his body, crushed him to death.

"The sketch shows the Chinese mode, by manual labour, of carrying one of the heavy granite columns from the quarry up an inclined plane to its position on the building. The united power of 36 men was thus applied, to carry with ease the columns, each weighing 38½ cwt., for about ½ mile in distance. This method of the application of manual power I consider might be very advantageously introduced, where mechanical means were not at command, to move with the labour of infantry a portion of siege equipment over a difficulty in transport."

Durnford was an invaluable second-in-command, as he took on most of the detailed drawing and administrative work. Collinson had been hard at work for two years on the detailed survey of the Island, and early in 1846 had completed a fine map of Hong Kong and some near-by islands, at a scale of 4 in to 1 mile with "vertical shading" to show gradients. He worked closely with the Royal Navy, who supplied much detail from their own surveys for Admiralty charts. Collinson also produced a series of pen-and-ink sketches of certain important features of the Island, designed to illustrate the topography, the nature of buildings and the new works carried out. He then received a posting to Wellington, in the young Colony of New Zealand, and sailed for Sydney on 10 June 1846, finally reaching Auckland on 19 September.

His complete survey and sketches were despatched to the Board of Ordnance in London, where they were reproduced. The sketches were bound in book form, 20 in × 15 in, the cover bearing this legend in delightfully ornate lettering:

Price Ten Shillings

Ten Outline Sketches
of
THE ISLAND OF HONG KONG
to accompany the
Ordnance Map of Hong Kong
Royal Engineers Office, Hong Kong
27th August 1846

This production was quite a novelty, and it is evident that it was sent out to many RE locations. One copy bore this manuscript instruction:

"To be deposited in the Royal Engineers Office, Mauritius, for the information and guidance of the Junior Officers of the Corps, as the Maps and Sketches together are considered to exhibit an excellent method of giving a correct idea of a country". It was signed at 84 Pall Mall, on 12 March 1847, by Lieut-Colonel R. C. Alderson, RE, Assistant to the IGF.

In March 1847 Lieut-Colonel George Philpotts, RE, arrived from Ceylon, to take over the duties of CRE. He found himself immediately embroiled in a military expedition to Canton, which ended in a bloodless victory. In the previous year two British sailors strolling through Canton, had been grossly ill-treated by a Chinese mob. This was reported to Palmerston, who instructed Sir J. H. Davis to "demand the punishment of the guilty parties to this outrage". The British merchants in Canton had in any case complained of the insecurity of their lives and property. On 1 April Major-General d'Aguilar, on instructions from the Governor, embarked two rather depleted battalions of Infantry, some Artillery and a RS & M detachment with "tools, scaling ladders and other material", in three warships and three hired craft. The object of the expedition was to obtain redress and compliance from the Chinese Commissioner at Canton. The force took several of the Bogue forts and reached Whampoa Island on the evening of 2 April without a shot being fired; the Chinese forts were almost untenanted, any form of military attack being quite unexpected.

The following day the forts on Whampoa were attacked, under the supervision of the General in person. As the garrisons speedily "evacuated the works by the rear", the attacks, led by Major Aldrich, were essentially Engineer affairs; the Navy and Infantry were occupied in keeping small Chinese craft and miscellaneous sightseers out of danger! Major-General d'Aguilar in his despatches of 15 April wrote: "Entrances were speedily effected by powder bags, which were applied to the principle gates by Captain Durnford and Lieutenant da Costa of the Royal Engineers. The guns were all spiked, the magazines exploded and the expedition next proceeded to the French-folly Fort, a strong work surmounted by a keep. The gate was similarly blown in." Here the departing garrison had unsportingly thrown water on the powder in the magazine, so it could not be blown up on the spot. Major Aldrich returned two days later with a supporting party and small naval craft to keep the inevitable sightseers at bay. An RS & M party under da Costa laid a charge of 300 lb gunpowder in the Keep, and Captain Durnford was left to "complete the train, and fire the charge, a duty performed in a very satisfactory manner", according to George Philpotts.

The demolition of the forts and the spiking of the guns had persuaded the Chinese Commissioner to comply with the Governor's demands, and the British force withdrew on 8 April. There were no casualties on either side, and the Sappers had an excellent exercise in demolitions. Lieutenant da Costa and four Sappers remained in Canton till 14 May, with the task of carrying out a survey of the

European factories. Major-General d'Aguilar, in his despatches, was indebted to George Philpotts for his "most judicious and scientific advice". He added, "My sense of Major Aldrich's services is not easily expressed. I had appointed him to act as my Aide-de-Camp, but I soon found that his abilities and knowledge were much too valuable. I charged him therefore with several operations under my own supervision; on the approach to the Factories I employed him in all the descents upon the Forts, which duty he performed with a promptitude, skill and ability beyond praise." Captain Durnford and Lieutenant da Costa also received their shares of commendation from the General.

This escapade came at the end of Edward Aldrich's time at Hong Kong, and, in accordance with instructions from home, he handed over his duties to George Philpotts. Lieutenant Chesney had been in poor health for some time, and after only two years in Hong Kong he left on the recommendation of a Medical Board in January 1847, for an eventual posting to Ireland. Thomas Collinson was already in New Zealand, and Edward Durnford stayed on in Hong Kong till March 1849. His last few weeks were upset by this distressing news item, which appeared in the *China Mail* of 1 March 1849:

"It seems that Captain da Costa of the Royal Engineers and Lieut. Dwyer of the Ceylon Rifles left the barracks yesterday (25 Feb.) afternoon at 4 o'clock for the purpose of taking a walk to the village of Awong-mo-Kok to the Eastward of Chuk-Chu. As they had not returned at 3 o'clock this morning, Lieut. MacDonald set out with an armed party in search of them, but discovered no trace of the missing Officers. From the fact of three spear heads, one of them marked with blood, having been found on the pathway near the village, it is surmised they have been murdered. The Superintendent of Police started off immediately to Chuk-Chu to make investigations, and a body of military has been ordered to scour the neighbourhood. At noon to-day, no trace of the two Officers has been discovered, but the village of Awong-mo-Kok was entirely deserted by its inhabitants."

The body of da Costa was found by police in the sea the following day. It was evident that he had been brutally killed by spears and other crude weapons; his body had then been dragged for some distance, weighted with stones, and thrown into the sea from some rocks. His funeral was attended by the Governor, the American Consul, all military officers and men, British and American naval officers, and many Government officials. The Coroner's inquest lasted four days, and there was direct evidence that, owing to some incident or misunderstanding in Awong-mo-Kok, both officers had been attacked and killed there. The Court's finding was that seven named Chinese villagers and others "did feloniously kill and murder Augustus Frederick Hippolite da Costa, and then withdrew and fled".

Major Aldrich completed his hand-over, and on 25 April 1847, sailed from Hong Kong on the wooden paddle steamer *Lady Mary Wood* (553 tons). This ship was the first P & O to establish direct communication for passengers and mail between Suez and Hong Kong, in August 1845, thus killing off the inefficient system of the East India Company and other merchant ships. After crossing overland from Suez to Alexandria, he boarded the crack P & O liner *Ripon*, an iron paddle steamer of 1,500 tons, then the most powerful ship of her size afloat; her oscillating cylinder engines delivered 900 hp, about double that of any comparable ship. He landed at Southampton on 28 June, and hastened to report in person to the IGF, Sir John Burgoyne.

Three weeks after his arrival in England, Edward Aldrich, then CRE London, was shown this rather unfriendly letter from the Treasury to the Secretary of Ordnance:

"It appears that Major Aldrich considered himself entitled to the Staff Salary of 1500 Rupees per month, assigned by the Bengal Regulations to the Chief Engineer of that Presidency, not being a General Officer, and that the Maj. General Commanding concurred with the view, and sanctioned the issue accordingly.

"It is certain that the above allowance is totally inapplicable in Maj. Aldrich's case. Under the most favourable interpretation of the East India Company's regulations, it would seem that, as CRE Hong Kong, he could not properly claim a higher Staff Salary than 600 Rupees per month, and My Lords consider he ought to be called upon to refund the difference, for the total period during which he received the higher allowance."

The sum involved was £3,475, and Sir John Burgoyne strongly supported Major Aldrich against the "refunding of so large a sum, received for some years, for the propriety of which he could entertain no doubt, particularly when continued undisputed for so long a period"—the best part of four years.

A terrific correspondence ensued; Aldrich, in a series of letters, made out a very good and reasoned case, pointing out in particular that, in addition to being CRE, he had been posted "to the Duties of Superintendence of Public Works and Head of the Survey Department". He produced the Orders to that effect and claimed that he was far superior to an Executive Engineer, whose highest Staff Salary was 600 rupees per month. In this dilemma, the Treasury put their rather biased case to the Court of Directors of the East India Company in London, for their interpretation; the result was not unexpectedly unfavourable to Major Aldrich. However on 20 January 1849 the Treasury informed the Secretary of Ordnance:

"My Lords are not indifferent to modify their decision to the extent of permitting him to retain 1000 Rupees a month, out of the 1500 Rupees received by him for Staff Salary."

Nevertheless, Major Aldrich continued to press his case for the retention of the full amount; but in June 1850 the Board of Ordnance, under pressure from the Treasury, had to instruct the Paymaster to stop his pay in liquidation of £2,133 overdrawn. At this stage his solicitor informed the Treasury that legal proceedings would be instituted unless the stoppage was cancelled; the Treasury took considerable umbrage, and on Sir John Burgoyne's advice the legal proceedings were called off. Meanwhile the affair spiralled upwards in the Whitehall hierarchy, and it was finally terminated by a submission from the Secretary at War to the Queen, the last words of which took this form:

". . . A sum of £2133. 16. 5 is due from Major Aldrich, and it is most humbly submitted to Your Majesty that the pay of Major Aldrich be withheld until the sum in question shall be repaid to the Public.

War Office
24 April 1851.

FOX MAULE
Secty. at War.

Approved . . . VICTORIA R."

Aldrich had no option but to comply with a Royal Command. The status of CRE in the British Colony of Hong Kong was therefore decided, by East India Company Regulations, to lie between that of Executive Engineer and "Chief Engineer, not being a General Officer", and it took nearly four years to achieve this!

This brief account has shown how the Royal Engineers first became established in that Far Eastern Outpost, and what befell some of them a few years later. It all happened in the days of paddle steamers and opium clippers, fever and dysentry, pirates and smuggling. It took six or seven months to send a letter to England and get a reply. In the early days a Sapper had no better than an even chance of surviving for three years against the ravages of ill health. That first little band of Engineers mapped the Island, built barracks and hospitals, tackled the drainage and provided drinkable water, so that, in a few years, the death-rate had been halved. A map of Hong Kong today commemorates the names of the highest in the Realm in such places as Victoria, Stanley Peninsula, Pottinger Peak and Mount Davis. The Generals gave their names to Mount Gough and Cape d'Aguilar, but, Gentle Reader, lest history fade, there still remain amid this galaxy of place names, Aldrich Bay and Mount Collinson.

Institution of Royal Engineers

CONDITIONS OF MEMBERSHIP

THERE are three categories of Members of the Institution of Royal Engineers, namely Honorary Members, Members and Associate Members. There are also Corresponding Members of Council who act as outposts of the Council in Commonwealth countries.

The Council from time to time invites gentlemen of eminence in professions, the activities of which are allied to the duties of the Corps, to become Honorary Members of the Institution of Royal Engineers.

Anyone who holds or has held a commission in the Royal Engineers in the Active or Reserve Armies of the United Kingdom, or who holds or has held a commission in the Engineer Corps of any of the Land Forces of the Commonwealth, is entitled to become a Member of the Institution.

Anyone who holds or has held a commission in the Royal Engineers of the Reserve Army of the United Kingdom, or in the Engineer Corps of any of the Land Forces of the Commonwealth, may elect to become an Associate Member, rather than a full Member, of the Institution if he so wishes.

A Member receives free copies of the quarterly *RE Journal* and the monthly Supplement thereto and copies of the RE List, published twice a year; he is entitled to the free use of the RE Library, Chatham; he is entitled to vote at Annual General Meetings and he is eligible to serve on Standing Committees that administer various functions of the Institution and to stand for election to the Council.

An Honorary and an Associate Member receives free copies of the *Journal* only. He is entitled to the free use of the Library, but he has no voice in the management of the Institution.

The annual subscription rates for Members are based upon substantive rank held whilst serving or on retirement from the service. They are:

Rank	*Serving*	*Retired*
Lieut-Colonel and above	£3 0*s* 0*d*	£2 10*s* 0*d*
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Applications for full or associate membership should be made to: The Secretary, Institution of Royal Engineers, Chatham, Kent, and in the case of applications from overseas they should be submitted through the senior engineer officer of the country concerned.

Woolwich Corner
The Royal Memorial Chapel, Sandhurst

In the article, published in the December 1967 issue of the *RE Journal*, it was erroneously stated that the RMA Woolwich Memorial in the Royal Memorial Chapel was dedicated by the Rt Rev V. J. Pike, Bishop of Sherborne, at one time Chaplain of the Royal Military Academy, Sandhurst. The Bishop was the last Chaplain of the Shop, and he was never the Chaplain at Sandhurst.

Correspondence

The Military Engineers
Association of Canada,
National Headquarters,
Ottowa, Canada.
6 February 1968

Sir,—We thought that it might be of interest for you to learn that in the recent past, the Ottawa Historical Society has contributed 107 pounds sterling to the upkeep of the grave of Lt-Col John By, RE, at St. Alban's Churchyard in Frant, England. To this the Royal Canadian Engineers Grave Fund and the Military Engineers Association of Canada have each also contributed £10.

The fund is in care of Commander C. R. Burgess, 1900 Oakdale Road, Tunbridge Wells, Kent.

Patriotic Canadians and especially Canadian sappers take a special pride in the work that Colonel By did for Canada. During the years 1826-1832 he supervised the construction of the Rideau Canal, a waterway using two river systems and a series of lakes connected by man-made masonry canals stretching 130 miles from Ottawa to Kingston. Two of the dams on this canal at Jones Falls and the Ottawa Hogs Back were in their day the highest man-made dams in North America.

To accomplish this magnificent feat of engineering, Colonel By spent a few thousand pounds more than had been allotted for the purpose by the British Government and as a result he was court-martialled when he returned to England and although acquitted, left the service and died within a year or two. Yet his great work lives on and his memory is perpetuated in local names in Ottawa which was itself known as Bytown until 1856. Ottawa's streets are wide because Colonel By had the foresight to make the roads a full chain wide and his good engineering planning is evident in the lay-out of Ottawa's principal streets and the location of its bridges. In recent years a new driveway along the canal has been built and named after him as has also one of Ottawa's new major buildings. Some forty years ago a movement was started to erect a statue to John By on the banks of the canal near the "sapper bridge" and about 300 yards from his engineer storehouse. The failure to complete this project was due partly to the depression of the 1930s followed by the second world war and also by the uncomfortable fact that no-one seems to know what Colonel By really looked like as there is no known authentic picture of him in any of our archives. However, the Ottawa Historical Society and our own Association maintain a continuing interest in this and it may be that one day there will be an authentic replica of his countenance in a place of honour in the city which owes him such a debt of gratitude.

The Ottawa Historical Society maintains the Bytown Museum in the storehouse mentioned above. This Museum which exhibits many objects and pictures of military and civilian interest from the early days of Bytown is kept open during the summer months and is visited each year by many thousands of tourists.

Another great sapper, Lt-Col Richard Clement Moody, RE, now buried at St. Peter's Churchyard, Bournemouth, England, has left a memory equally cherished by the people of British Columbia as it was he who landing in the then colony of British Columbia and Vancouver Island in 1858 built its first capital and the great road into the goldfields of the interior.

Perhaps Canada has repaid part of the debt to these two great pioneers by sending to the Royal Engineers such builders of empire in other parts of the world as Sir Percy Girouard, Sir Gordon Guggisberg, Sir Godfrey Rhodes and many others right down to Sir A. Edward Grasett.

At a time when the milestones of imperial glory are disappearing in the dust and the pax brittanica is becoming just a memory, we must endeavour not to let the glory of these men and what they have done as engineers in war and peace fade into oblivion or estrangement with the outposts of empire that they once served so well.—Yours sincerely, N. Sadlier-Brown), Lt-Col, National Secretary and Corresponding Member of the Council of the Institution of Royal Engineers.

Note by Editor. The Institution of Royal Engineers has for some time made a small annual payment for tending Colonel By's headstone in Frant churchyard.

Memoirs

MAJOR-GENERAL SIR DONALD J. McMULLEN, KBE, CB, DSO

MAJOR-GENERAL SIR DONALD JAY MCMULLEN, Director-General of Transportation of the British Expeditionary Force sent to France in September 1939, and then Director of Transportation, The War Office, from 1941 until the end of the war in 1945, died peacefully on 12 November 1967 after many years of illness, courageously borne, aged 76 years.

He was the son of John Alexander McMullen, MBE, who, although not a young man, served in the Royal Flying Corps during the First World War and, at an age when most men would have ceased to be an active pilot, constantly and intrepidly flew his own autogiro the length and breadth of England, Scotland and Wales and across the stormy seas to Ireland, a remarkable feat when the machine's maximum airspeed did not greatly exceed fifty miles an hour.

Educated at Bradfield College and the Royal Military Academy, Woolwich, Donald McMullen was commissioned into the Royal Engineers on 20 July 1911. After his Young Officer Training at Chatham he was sent on a Long Mechanical Engineering Course at the Doncaster Workshops of the Great Northern Railway. Like his father, however, he was at that time attracted to a form of transport not fettered by a pair of parallel steel rails, and in 1913 he obtained his Royal Aeronautical Club's Certificate as a Qualified Aeroplane Pilot. His service during the First World War was, nevertheless, to be with Military Railways and not alongside brother Sapper officers who fought so gallantly in the air, and indeed for most of his long and distinguished service he was employed exclusively on Movements and Transportation duties, rising eventually to the exacting position of Director of Transportation at the War Office at one of the most critical periods in our history and seeing his arduous duties through to final victory.

Recalled from his Mechanical Engineering Course with the Great Northern Railway on the outbreak of war in August 1914, he was at first employed in a temporary junior staff appointment at the War Office before being posted early in 1916 to the 117th (Railway) Company, RE. From then until the end of hostilities he served overseas without a break. First on the Island of Mudros, selected, almost at random off the map by the General Staff, as an advanced base for the ill-fated Gallipoli Campaign. Then in Salonika with initially an unhelpful French ally and a completely non-cooperative Greek Government, but in time to see considerable railway construction work in the base area and later in support of victorious advances across mountainous country into Serbia, Bulgaria and European Turkey. And finally with Allenby's Egyptian Expeditionary Force in Palestine, where the military railway L of C from Egypt across the waterless Sinai Desert, constructed and operated by the Royal Engineers, was no less a weapon of ultimate victory than was the railway laid by Girouard in support of Kitchener's invincible advance on Omdurman some twenty years before. McMullen sailed for Mudros as a subaltern in 1915; the following year he became a captain and in February 1917 a major. In December 1918 he was awarded the DSO for distinguished services in Palestine.

Between the two world wars he was seconded for many years to the Egyptian State Railways, being the last of a long line of Sapper officers to enter their service. During this period he married, in 1922, Evelyn Frances, daughter of the Reverend G. F. Packer, OBE, one-time Rector of Tickenham, Somerset. They had one son and two daughters.

From January 1930 to the end of 1934 he was an Instructor at the Railway Training Centre, Longmoor, under Lieut-Colonel (later Brigadier) L. Manton, possibly one of the most far-seeing Commandants Longmoor had ever known, under whom the military railway line to Liss was completed in 1932, and the first

passenger service to Bordon opened; experiments were carried out in rapid plate-laying, capable of being employed on active service, and astonishing speeds of laying track were achieved; the Signal School and that great training aid, the miniature railway, were installed; the officers' and soldiers' accommodation were greatly improved and St Martin's Garrison Church rose from a converted forage barn; a series of exercises and practical demonstrations, attended by Staff College students, were run on Movements and Transportation subjects, and the expanding strength of the RE Supplementary Reserve enabled the establishment in the Reserve Army of at least a nucleus of military port operators. Throughout all this there were constant RE staff studies on the technicalities of Movements and Transportation and often heated discussions on their improvement and rationalization.

Then followed his only Army service away from transportation duties when, in January 1935, Major McMullen assumed command of the 1st (Fortress) Company, RE, at Gibraltar, one of the very few overseas stations where no railway of any description operated. However, he strongly advocated the construction of a tube train, with intermediate stations, from the North Front to Europa Flats, which was considered by many at the time as sheer folly; however, within a few years a tunnel —colloquially known as the "Poor Relation"—was excavated by wartime Sappers following almost the very alignment he had suggested, giving a covered lateral communication within the Rock, but which, of course, did not embody his contemplated electrified railway system. With his wife and young family he entered whole-heartedly into all the garrison social activities and sports. To his great delight his elder daughter, at that time a very young girl, won the coveted Ladies' Cup at the Royal Gibraltar Yacht Club to the consternation and chagrin of the many expert lady helmswomen Club members, and he and his daughter followed the Royal Calpé Hounds across the crags and through the cork woods to the bitter end of many a day's hunting. He rode in the 1935 Calpé Point to Point. It was a great loss to the Fortress when, early in 1936, he was called away to become Assistant Director of Transportation Egypt, Palestine and Trans-Jordan at a time when the Mufti of Jerusalem had organized a general strike to paralyse the Palestine Mandate civil government whilst Arab bands attacked Jewish settlements, disrupted all forms of communication and damaged the pipeline to the Haifa refinery. The railways, running mostly through long stretches of sparsely populated country, were in particular very susceptible to interruption by sabotage, and Sapper units had to be employed on track maintenance and repair and the operation of trains and the pilot trolleys which preceded them as an anti-mine safety precaution. Once the internal security of the country had become more firmly established the metre-gauge railway from Haifa to Jenin, Nablus and Tulkarm was reopened. For his work as AD TN during the emergency McMullen was awarded the OBE in the 1937 Coronation Honours List.

In July 1937 he returned once more to Longmoor to become Commandant of the Railway Training Centre. During his time as Commandant he concentrated on consolidating the work of his predecessors and in the deliberate preparation for an inevitable war which would demand a vast increase in the number of trained transportation units. The Supplementary Reserve Headquarters at Longmoor was increased to three Sections, each with its own carefully hand-picked regular Adjutant, to cover Railways, Docks and Movement Control. An SR Docks Group was set up, in addition to the SR Transportation units raised mainly from the personnel of the four civil Railway Companies, with mobilization headquarters at York, and another was formed from the Port of London and other southern port Authorities. The famous landship SS *Applepie* made its appearance for stevedore training. The Longmoor Sappers, both Regular and Supplementary Reserve, under their energetic and thrustful Commandant, responded with enthusiasm and quiet confidence. Their testing-time was not far distant.

On the outbreak of war in September 1939 McMullen assumed his mobilization appointment of Director-General of Transportation of the British Expeditionary

Force. RE Transportation units were among the first troops to land in France, where they were employed on discharging stores and vehicles, the building and operation of marshalling yards and rail-served depots and the collection of large stocks of material for the development of rail communications. They also played a significant part in the evacuation of British troops from Dunkirk and other Channel ports after the German break-through in May 1940. For his part in these operations McMullen was created CBE in the 1940 Birthday Honours List.

His final appointment, the culmination of his specialized military career, was that of Director of Transportation at the War Office. Within the confines of this Memoir it is only possible to sketch briefly the vast and ubiquitous transportation tasks for which he, as Director, was responsible from the dark days of Dunkirk to the final defeat of our enemies. Manpower figures can perhaps best indicate the magnitude of these tasks. From a prewar strength of some 500 regular and 3,500 Supplementary Reserve troops employed by the RE Transport Service the number grew eventually to more than 146,000. After the collapse of France the Middle East became the main centre of overseas transportation activity, the 170-mile Palestine-Syria Railway, which included a tunnel a mile long, was built and opened in one year. The Western Desert Railway was extended from Mersa Matruh to Tobruk. In Egypt existing ports were improved and new military ports built to serve the Middle East base; a ship-yard for the construction of Z craft was established at Ismailia. The ports of Lybia and Tripolitania were repaired and opened to support the advance of the Eighth Army from El Alamein to Tunis. The capacity of the mountainous Trans-Persian Railway was increased tenfold to carry supplies to Russia.

In North Africa, Sicily and Italy some 20,000 RE Transportation troops were deployed and on many occasions the progress of military operations in Algeria and Italy primarily depended upon the capacity of ports and railways. In Italy great difficulties were experienced due to widespread and expert enemy demolition of the ports and civilian railway systems, but these hindrances were largely overcome by the use of port repair ships and "Unit Construction" railway bridging and trestling, both of which had been specially developed to meet such contingencies.

For the assault on North-West Europe the design and assembly of the Mulberry prefabricated harbours were largely the work of the RE Transportation Service and the actual construction of Mulberry B at Arromanches was entirely a Transportation responsibility in conjunction with the Royal Navy. The tonnage discharged from ships and craft over the Normandy beaches, and later through captured ports, to support the operations up to VE-Day amounted to almost 5½ million tons, a remarkable feat when most of the port facilities had been completely demolished by the withdrawing German forces. The reopening of the railway system was also hampered as a result of widespread devastation caused both by Allied bombing and enemy demolitions. Hardly a single railway bridge had been left standing. However, by VE-Day a main railway route, 650 miles in length from Bayeux to Bremen, was in operation and among the major rivers bridged on this route were the Seine and the Rhine. During the operation of the British and Canadian forces in the Low Countries the RE Transportation service operated and controlled a fleet of over 6,000 assorted craft on the canals and rivers of Holland and Belgium to relieve the overloaded railways and road transport.

In India and South-East Asia Transportation played an equally prominent part. In the Arakan a fleet of coastal vessels, creek steamers and local craft of all kinds was organized and operated; on the Chindwin a fleet was built up from craft transported in sections over the mountains and jungle; for the railways needed to support the advance of the Fourteenth Army locomotives were imported, some complete and some in sections, by air, road and river.

During his famous lecture, given at the Royal United Services Institution in October 1945, on the campaign in NW Europe, Field-Marshal Montgomery said: "It is not possible in such a short survey to go into any detail concerning the vast and complicated machinery necessary for the support of a modern army in the field.

I will, however, mention the tremendous importance of Movements of Transportation. Their problems in this campaign were immense." Tremendous and immense indeed were the responsibilities that rested for four long years on the able shoulders of the Director of Transportation at the War Office. In recognition of his brilliant work McMullen was created CB in 1944 and knighted in 1946. He was also made a Commander of the American Legion of Merit and of the French Legion of Honour.

In September 1946, four months after VE-Day, McMullen joined the control Commission for Germany, becoming Deputy Chief (Executive) of the Transport Division of the British Element of the CCG, and he held this important and exacting post until his retirement in July 1948 after thirty-seven years of outstanding service—a truly great Sapper officer, and surely one of the most dedicated Longmoor has ever produced.

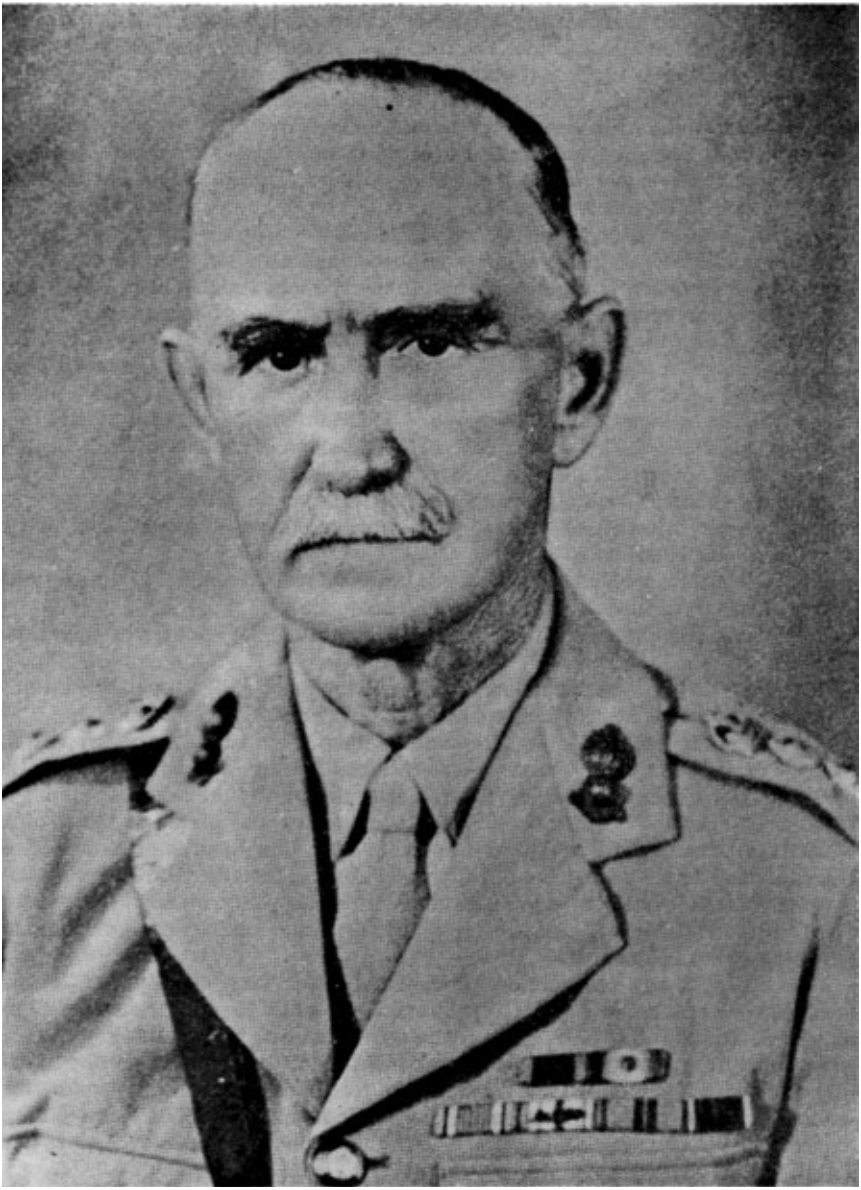
BRIGADIER R. C. R. HILL, DSO

ROWLAND CLEMENT RIDLEY HILL, who was commissioned into the Royal Engineers in the days of the Queen-Empress Victoria, died in Bangalore, India, on 7 October 1967, aged 88 years. For most of his long and distinguished military career he served with the Indian Sappers and Miners. He was Commandant of the Queen Victoria's Own Madras Sappers and Miners from 1923 to 1929. He became Colonel of that Corps in 1942 and was created their first Colonel Commandant in 1946.

Son of Major-General C. R. Hill, Royal Artillery, he was educated at Clifton and the Royal Military Academy, Woolwich, and commissioned into the Corps on 25 September 1899. On completing his Chatham training he was posted to the 30th (Submarine Mining) Company, RE, at Plymouth, where, after special instruction in the use of the Brennan torpedo, he became the Station Torpedo Officer. In 1903 he was posted to India, where he was to soldier for so much of his life, and joined the recently reorganized Indian Submarine Mining Corps. He served first with the 3rd Company at Calcutta and, in 1904, he was given command of the Aden Section, where he saw active service in the operations in South Arabia and the Yemen against the turbulent dissidents of that time, supported and egged on by an outside power. He returned to India the following year, where he served successively with the 1st and 3rd Companies of the Indian Submarine Mining Corps at Karachi and Calcutta.

From 1906 until 1910 he was employed on Military Works in Cawnpore, Calcutta, Jullundur at Lahore. In May 1911 he was posted to the Bengal Sappers and Miners, whose designation had been changed from the 1st Prince of Wales Own to the 1st King George's Own Sappers and Miners on the accession of King George V to the throne the year before. He joined the 6th Company, then at Delhi, which was employed with other Sapper and Miner Companies on preparations for the Coronation Durbar, which included the State Entry, the Durbar itself, the Royal Review and the State Departure, covering the period 7 to 16 December. The famous Ridge, from which the intrepid demolition party of the Bengal Sappers had fifty-four years before rushed forward through a hail of musketry fire to blow the Kashmir Gate, was covered with rich, colourful pavilions and tents and lit at night by a galaxy of twinkling lights.

A light railway, the Delhi Durbar Light Railway, miles of metalled roads and camps for the VIPs and their entourages and the many regiments attending the Durbar were built. The Bengal Sappers even constructed church furniture in the form of *prie-dieu* for the King-Emperor and his Queen and for the Viceroy and his Vicereine and stalls for the bishops, clergy and choirs attending the Durbar. Representative units of the three Sapper and Miner Corps were brigaded for the Royal



Brigadier R C R Hill DSO

Review, held in a vast amphitheatre prepared for the occasion, and the Bengal Sappers (The King George's Own) provided a Sovereign's Guard at the Royal Camp.

Shortly after the Durbar the 6th Company was sent to the densely wooded and mountainous country, inhabited by the Abors and Mishmis, on the wild upper reaches of the Bramaputra between Assam, China and Tibet to support a survey party charged with demarcating a boundary between land claimed by both the Governments of India and China. The rainfall was prodigious; landslides and great fallen trees frequently blocked the steep mountain tracks and life was made almost intolerable by voracious leeches. The Company built eight suspension bridges, using locally produced materials, the longest being one of 220 ft span before the operation was concluded and the Bengal Sappers were brought back to Roorkee.

Hill was on his way home from India on leave in July 1914 and he was hurriedly recalled from Aden to command the 1st Field Troop, composed of Sikhs of the Bengal Sappers, affiliated to the Secunderabad Cavalry Brigade which, with the 3rd (Lahore) and 7th (Meerut) Division, comprised the first contingent of the Indian Expeditionary Force sent on mobilization to the Western Front. The Secunderabad Cavalry Brigade disembarked at Marseilles towards the end of September 1914, but there was little for the Field Troop to do and in the summer of 1915 it was disbanded and Hill was given command of the 2nd Indian Field Squadron of the reorganized Indian Cavalry Corps. He did not, however, accompany the Indian troops when they left France for Mesopotamia in December 1915. Many Royal Engineer officers then serving in France were anxious to join the Heavy Section of the Machine Gun Corps, a cover name for the "Tanks" largely developed by Lieut-Colonel (later Major-General Sir Ernest) Swinton, and other Sapper officers, and Hill, with his previous engineer cavalry training, was one of those chosen. He was eventually given command of a tank battalion.

For his wartime services he was awarded the DSO in December 1917, mentioned in despatches three times and made a brevet major.

In January 1920 he married Margaret, daughter of Percy Vickers of Wilmslow, Cheshire.

Returning to India, he once more served with the 1st KGVO Sappers and Miners as Superintendent of Instruction and then as Superintendent of Parks.

On 28 December 1923 he was appointed Commandant of a sister Sapper and Miner Corps—the Queen Victoria's Own Madras Sappers and Miners, a post he held for six years. Polo had been restarted after the war by the Madras Sappers in 1920, when a team entered the Christmas Tournament and played in the Madras Novice's Tournament the following March. Shortly after becoming Commandant Hill captained a polo team that competed at Calcutta in both the IPA Championship and the EZRA. Under his captaincy the Madras Sappers won such major local events as the HH Maharaja of Mysore's Cup, the Rajkamul Deseraj Urs Cup and the Maharajah of Venkatagiri Cup.

A tour of duty as a brigadier on the General Staff at Army Headquarters, Simla, then followed and his last active appointment was Chief Engineer Southern Command, He retired in July 1935, but his close connexion with the Madras Sappers was to continue for many years. In 1942 he became their Colonel and, when the Indian Engineers were honoured with a Royal title in recognition of their outstanding war service, Hill was gazetted as the first Colonel Commandant QVO Madras Group, Royal Indian Engineers, on 5 December 1946, an appointment he held for two years. T.P.B. writes:

Hill came to the Madras Sappers at Bangalore from the Bengal Sappers in Roorkee having spent most of his service in India with the Bengal Sappers. It must have been a difficult transfer for him and it was a great tribute to his wisdom and character that he so rapidly absorbed the spirit of the Madras Sappers and gained from his new command their affection and admiration.

He was an admirable Commandant in every way. In addition to his official duties R.C.R., as he was affectionately known, took a leading part in the sporting

activities of the Corps. He captained the Corps polo team and led them to victory in many local tournaments. He was also a first-class shot and I have many happy memories of snipe shooting in his company. There were some days when the shoot in the morning was not so good, but always on those occasions, after being fortified by a tiffen of beer and curry puffs, R.C.R. was devastating and no snipe was safe!

After he left the Madras Sappers he became Chief Engineer Southern Command at Poona and on his retirement he returned to Bangalore and settled there. He lived in the Club, where the staff served him with great devotion.

The Madras Sappers never ceased in his years of retirement to show their respect and admiration for him. He became established as a father figure. It has been a constant delight to retired RE officers who served under R.C.R. to know that in his retirement he was so greatly cared for and respected by his old Command. During his retirement his principal interest was racing and he was very successful as a breeder and owner. Because of those activities he had a large circle of civilian friends in the South of India by whom he was held in great esteem. He was given a military funeral and the Madras Sappers lined the Road from the Sapper Lines to the cemetery in a final tribute to their old Commander.

R.C.R. is mourned by many, civilians and soldiers alike. He was a grand man, and a great Commandant who was always firm, wise and compassionate.

The Hon Secretary of the UK Branch of the Madras Sapper Officers' Association writes:

Brigadier R. C. R. Hill was Commandant of the Madras Sappers from 1923 to 1929. After a tour as Chief Engineer, Southern Command, Poona, he settled in Bangalore, where successive Commandants have always invited him to regimental functions and treated him with great respect and attention.

His last illness was short. From the middle of September he was attended in his room at the Bangalore Club by his friend and medical adviser, Colonel D'Souza, who writes that it was evident that his heart and circulation were failing through fair wear and tear. On 3 October, on Colonel D'Souza's advice, he was taken to the Military Hospital, where he was given the greatest attention. He died on the evening of 7 October 1967.

The Madras Sappers organized a military funeral. The president of the Club, the Commandant (Colonel C. B. Sridharan) and Madras Sapper officers were pall-bearers. The coffin, draped with the Union Jack, was taken on a gun carriage to Kalpally cemetery (beyond Meeanee Lines), Madras Sappers lining the route.

As a tribute to his memory there was a one-minute silence at the Mysore races, held in Bangalore that week, and the Club Annexe is now the "Brigadier Hill Annexe", with a memorial tablet to him. To the end, "R.C.R." was honoured and respected by his many civilian friends and by the Corps.

BRIGADIER T. H. EVILL, CBE, DSO

THOMAS HAYWARD (TOM) EVILL, CRE of the 43rd (Wessex) Division at the Seine Crossing and CRE 3rd Division during the final stages of the war in North-West Europe, and later in Palestine and Egypt, CRE 1st Division in the Canal Zone, CCRE 1st (British) Corps in Rhine Army and Chief Engineer Northern Command, soldier, artist, sportsman, devoted *pater-familias* and Christian gentleman, died on 28 October 1967 after a long and courageous battle fought against an incurable affliction, aged 56 years.

The son of Colonel Charles Ariel Evill of Brynderwen, Chepstow, he was educated at Cheltenham College and started his military career in 1930 as a subaltern in the Territorial Monmouthshire Regiment, his County Regiment.

In 1936 he was granted a Commission in the Royal Engineers, and his prewar experience, and the first years of his wartime service, were exclusively with search-lights, consisting of a tour of duty with the 1st Anti-Aircraft Battalion, RE, and then as an Instructor at the School of Anti-Aircraft Defence.

In May 1941 he was posted to the 43rd (Wessex) Division and shortly afterwards he was given command of the 204th Field Company, RE. His division was heavily engaged in the "dog fight" in the Normandy Beachhead in June/July 1944 and in the subsequent breakout and, when the CRE was wounded on 16 August, Tom Evill temporarily took his place. His division led the advance to the Seine and his sappers built a Class 9 Folding Boat Bridge over the river at Vernon. It was the first major opposed river-crossing operation in NW Europe and it was to be a prelude to many more. Tom Evill continued to serve as CRE 43rd (Wessex) Division until September when a new CRE arrived and Tom returned once again to command the 204th Field Company.

In November, however, he became CRE 3rd Division and he remained with that formation throughout their long, hard slog to Bremen, when the historic signal was received to: "Cancel all offensive ops forthwith and cease fire 0800 hrs 5 May 45" as a prelude to the unconditional surrender of the defeated German forces in NW Europe. Tom Evill's personal courage and devotion to duty during the fighting from Normandy to the Baltic were an inspiration to all and were officially recognized by the immediate award of a DSO. Badly wounded in the head in March 1945, he managed to change his "label" during a critical stage in his medical evacuation and he somehow eventually got back to his Divisional Headquarters before he was properly fit and, indeed, his wound fully healed. D.R.D., who served in the Division at that time, writes of the great mutual and long-lasting respect that grew up between the Divisional Commander, Major-General (later General Sir Lashmer) Whistler, and his CRE, and how Tom Evill formed part of that hand-picked planning team on which General "Bolo" Whistler relied so much during the division's successful operations in NW Europe.

After VE-Day the Division was withdrawn to Belgium to prepare to fly to America to take part in a seabourne assault on the Japanese mainland. The atomic bombs on Hiroshima and Nagasaki altered these plans and the division was sent to Palestine in October 1945. There they were engaged in attempting to stem the pitiable inflow of illegal Jewish immigrants from Hitler's concentration camps and the terrorist activities of the Stern Gang and Arab nationalists. When the British Government surrendered the Palestine Mandate the division was withdrawn to Egypt.

Posted home in November 1946, he spent a short while at 156 TC before attending No 18 Staff Course at Camberley. Two years in staff appointments in Austria followed and in January 1948 he went to the Joint Services Staff College. On graduating from Latimer he spent a short time as Second-in-Command of 8th Training Regiment, RE, before returning once again to the Canal Zone of Egypt in June 1951 as CRE 1st Division and Officer Commanding 22nd Field Engineer

Regiment during the last phase of the seventy-two years that British troops had served on Egyptian soil.

Posted home again in 1954, he became GSO1 (Ops and SD) at Headquarters Western Command, and in April 1956 he was promoted colonel and given command of the West Country 24th Engineer Group (TA), whose Headquarters were at Liverpool.

In August 1958 he was appointed Colonel E at Headquarters Northern Army Group and in March 1960, on promotion to brigadier, he became CCRE I (British) Corps, a post he held for two years before his final appointment as Chief Engineer, Northern Command, at York. He retired on 12 September 1964 and shortly afterwards took up a Retired Officers' post as Youth Liaison Officer, Western Command. He was awarded the CBE in the 1965 New Year's Honours List.

Besides being a splendid soldier, Tom Evill was an artist of great creative genius. D.R.D. writes that anyone who has seen his illustrations of the charming book *Wahid the Little Camel* or the Christmas cards he drew over the past eleven years could not fail to appreciate his sensitivity and sparkling wit. His art was so deeply ingrained in him that almost incredibly he was able to draw and paint before, as a child, he could read or write or, more recently, before he had regained the full co-ordination of his limbs after his operation last spring. Those who saw his work exhibited in last year's Combined Service Art Exhibition in London could not but wonder at his achievements and his courage and determination to overcome the handicap to which lesser persons could have so easily succumbed. When on active service his genius for improvisation enabled him to use whatever media came to hand, including vehicle and camouflage paints. He was also an expert modeller. For the 3rd Division he painted a fine picture of the Rhine Crossing and carved little statuettes of soldiers of the division in action. He also painted a picture of the 2nd Battalion the Royal Ulster Rifles in the assault on Bremen in Buffaloes. When the 3rd Division was withdrawn from Palestine to the barren, windswept transit camp at Qassasin, Tom would, of an evening, sit on the steps of his caravan and with his sharp jack-knife, which all good Sappers carry, delicately carve out of pieces of rough, soft Fayid stone animated little military figures, splendid, lifelike and full of action. During his subsequent posting to the Middle East he produced most charming pictures of the Great Bitter Lake, tranquil and grey in the morning and shining crimson in the evening light, and the mountains and battlemented castles of Cyprus. Perhaps his artistic achievement that will be most long remembered in the Corps is the 38 Corps Engineer Regiment silver centrepiece of an Arab dhow. Tom Evill created the model from which Garrards, the Crown Jewellers, cast the centrepiece, which made its first public appearance at the Corps Guest Night, held during the 1966 Engineer-in-Chief's Conference. The dhow, cleaving through the water on a broad reach, is a wonderful example of Tom Evill's artistic skill and his astonishing photographic memory that enabled him to depict with remarkable exactitude the position of the crew, the set of the sails and the details of the rigging.

In his love of sport his chief delight was with the gun and rod. He had a deep knowledge of natural history. He was a first-class shot and angler; he also tied flies with consumate skill. After his recent operation, when he was told that he would be left with a disability which might prevent him from tying intricate knots, he sent at once for his casts and flies to prove that, no matter what the difficulties, he could succeed against any odds.

In September 1938, at All Saints' Church, Lingfield he married Felcie Buchanan, only daughter of Mrs Robertson and the late Captain S. L. Robertson. They had three daughters: Marion (Marty), Rosemary (Trindy) and Alison (Bubbles). They were a devoted and close-knit family. Tom and Felcie celebrated their Silver Wedding at York and it was there that the ADC to the Army Commander (also a Sapper officer) made his successful bid for Marty's affections. When their son Andrew, Tom's first grandchild, was born he became the pride and delight of the whole family.

Tom's company was always stimulating and his personality radiated an infectious enthusiasm and energy. He was also a devout practising Christian. The tiny church at Mounton, close to where Tom now rests beside his parents, is never without some member of the Evill family present on Sundays. Even when the family was widely scattered serving their country during the war years, there was always at least one member praying there.

He was always kind, thoughtful and considerate towards his friends, revealing the genuine humanity that was part of his character. As an example of his human touch, when serving in BAOR, he arranged for the son of an officer, who had previously served on General Whistler's staff, to act as the General's ADC when he visited ACF units training in Germany.

M.C.A.H. writes:

"Tom Evill was a man of many parts. I first got to know him when he commanded 204th Field Company in 1944. After his previous CRE was wounded Tom acted as CRE for several weeks and might reasonably have expected to remain as the permanent CRE of 43rd (Wessex) Division, for he had done the job extremely well. He might have felt some resentment when a new boy (myself) arrived from Home to be the new CRE. He certainly never showed the slightest trace of resentment. (To show resentment would have been rude; and good manners were one of his most visible attributes.) I do not believe he even *felt* resentful. He was not made that way. He was happy with his company and they were happy with him. A unit always reflects its CO, and 204th Company reflected Tom: well trained, quick in the uptake, perfectionists in all they attempted and with an air that was somehow always cheerful even in the most bloody surroundings.

"I remember him before the first battle we took part in together. The scene was his Company Command Post in an orchard. Sufficient enemy shells were falling for his driver to prefer a slit-trench to the half-track. 'Where is the Major?' I asked. 'In there, sir,' replied the driver, pointing. I looked round the canopy of the vehicle and there was Tom, pen in hand, busily writing. 'Whatever are you writing?' I asked. (To be writing an operation order seemed unbelievable!) A slow smile suffused his face. 'Actually,' he replied, 'I am writing to my wife—and I hope it won't be for the last time.'

"Happily it was not; for in his family life and in his home one saw some of his most charming facets. To see him tease one of his daughters—or, more likely, to be teased by her—was to witness a perfect scene of family love and mutual understanding.

"I think he drew his strength from his home. Born into a much-respected family in a gracious home; happily married to a loving wife, with the expectation of retiring to his beloved Brynderwen in the village of Pwllmeyric, near Chepstow, he typified Cromwell's ideal soldier: a man who 'knows what he fights for and loves what he knows'.

"He truly loved his home; and in retirement lavished on it and the grounds around all the skill of his artistic eye and hand. As his guest one was at once aware of being in the presence of the real thing—a happy and lovable family man, standing where his fathers stood before him."

COLONEL W. T. EVERALL, OBE, MICE

COLONEL W. T. EVERALL, OBE, Chevalier of the French Legion of Honour, MICE, died in Braintree Hospital on 26 December 1967, aged 87 years. In the Corps he will be remembered as the designer of an equipment railway bridge, used extensively in the Second World War, named after him.

On leaving school he received his engineering training at the Birmingham Technical College, and after employment with the BSA and the Patent Shaft and Axletree Company, he was, in 1910, appointed bridge engineer on the Indian North Western State Railways in the Punjab. During the course of his duties he was on several occasions loaned to the Army for bridging work on campaigns on the North-West Frontier. For these services he was awarded the OBE and he was twice mentioned in dispatches. He rose to become Chief Bridge Engineer of the North Western Railway and he designed the Attock strategic railway bridge over the River Indus near the Khyber Pass. He presented a paper on this project to the Institution of Civil Engineers during their 1929/30 Session.

During the Second World War he was given a commission in the Royal Engineers and, serving under the Director of Transportation, he was employed as a bridge designer and on problems connected with the design of the Mulberry Harbours to be used by both the British and American forces. He accompanied Sir Winston Churchill's party to America to discuss technical details with his American opposite number.

In 1948 Colonel Everall presented four papers to the Institution of Civil Engineers, two on the general design and methods of erection of Military Railway Bridges developed during the war (one of which, the Everall Sectional Truss Railway Bridge, bore his name), one on the Cross Channel Ferrying of Locomotives and Rolling Stock and one on Sectional Dock Caissons for Emergency Port Repair. His papers, together with many others on military engineering problems, were published by the Institution of Civil Engineers as a symposium of papers entitled the *Civil Engineer in War*.

The Royal Engineers were indeed fortunate to have counted among its wartime officers a Member of the Institution of Civil Engineers of Everall's calibre and professional competence.

Book Reviews

ARMOURED CRUSADER

MAJOR K. J. MACKSEY, MC, RTR

(Published by Hutchinson & Price. Price £3 net)

Major Macksey's book is a flowing and lavish panegyric of the late Major-General Sir Percy Hobart, KBE, CB, DSO, MC (better known in the Army as General Hobo), and Captain Sir Basil Liddell Hart has produced an equally eulogistic foreword to it.

Educated at Clifton and the Shop, Hobart was commissioned into the Royal Engineers on 29 July 1904. After his Chatham training he sailed for India in 1906 and served with the 1st Bengal Sappers and Miners, where he was quickly plunged into polo, pigsticking, big game shooting, exploring inaccessible far-away places, and in punitive expeditions against dissident Frontier tribesmen. He also served on the military staff charged with the arrangements for the 1911 Coronation Durbar at Delhi. Prevented by leave out of the country, and then by sickness, from accompanying the first contingents of the Indian Expeditionary Force sent to France on the outbreak of war in August 1914, he did, however, fight most gallantly with the Bengal Sappers during the second battle of Neuve Chapelle, where he was awarded the Military Cross, and at Festubert in May 1915. He also served on the staff in Mesopotamia, where he was wounded, taken prisoner when his spotter aeroplane was shot down, and subsequently escaped. He served again on the staff in Allenby's final victorious cavalry advance to Aleppo.

He attended the first postwar course at the Staff College, Camberley; Bernard Fryberg, Lord Gort, Alan Brooke, Maitland Wilson and Bernard Montgomery were amongst his fellow students. A tour of duty at the War Office followed and Hobart became deeply persuaded by the arguments of Colonel J. F. C. Fuller that armoured vehicles would be the key of future war. Returning to India in 1921, he served with distinction on the staff of the Wana Column and later as a GSO2 at Eastern Command. He was made a brevet lieut-colonel and awarded the OBE. In April 1923 he transferred to the Tank Corps and took up his duties as an Instructor at the Staff College, Quetta, being the sole representative of that Corps on the Directing Staff.

The major part of the biography is devoted to his activities in the new Corps of his choice, and his own particular views on how armour should be used in battle. His outspokenness and his intolerance of other views and personalities brought about his downfall and he was retired from the Army with the rank of major general. As a result, in the early days of the Second World War he served as a private in the Home Guard. He was, however, reinstated and later given command of the specialized armoured units, the Funnies, that were being formed for the invasion of north-west Europe, and his 79th Armoured Division played a significant part in the operations of 21 Army Group until the German surrender at Lüneberg Heath on 5 May 1945. In this latter connexion the biography strikes a most discordant note. Although pride of place is given on the dust cover of the book to a photograph of a Churchill AVRE, the parts of the book dealing with the Assault Engineers, the development and production of their specialized equipments and their battle exploits depart from the truth and in places there are lamentable travesties of fact.

This particular aspect and many other incidents described in this laudatory song of praise for a departed hero are grossly unfair to many Royal Engineers and will cause resentment among a host of Sapper readers of the book. Very few, if any, serious-thinking soldiers would agree with the Top of the Pops grading, claimed by the author, that General Hobo ranked among the Top Ten of the great British Generals of the Second World War.

STRUCTURAL LIGHTWEIGHT AGGREGATE CONCRETE

J. K. NESBIT, MIStructE, MSoc CE(France)

(Published by Concrete Publications Ltd, Buckingham Gate, London, SW1. Price 28*s*)

Amendment No 1 to BS Code of Practice C.P.114:1957, which was published in 1965, contained for the first time recommendations for the structural use of concrete made using light weight aggregates. Although the design methods for this type of concrete are similar to those made with the more standard dense aggregates, the criteria given in the code are different. This very well presented book covers all aspects of design of light-weight aggregate concrete structures.

This book is presented in a novel way in that each left-hand page of it gives the actual clause of CP 114 in its entirety and a commentary on each right-hand page gives recommendations and explanations on the applications of the code to light-weight aggregate concrete. This form of presentation is excellent for the concrete designer, as it avoids the necessity for tedious cross-referencing and must save time and effort as a result.

The light-weight aggregates permitted by B.S. 3797 and B.S. 877 are as follows:

Aglite —an expanded clay aggregate produced on a sinter-strad machine.
Leca —an expanded clay aggregate produced in a rotary kiln.
Lytag —manufactured by pelletizing and sintering pulverized fuel ash at high temperature.
Foamed slag—a crushed angular aggregate manufactured by treating molten blast-furnace slag with water.

The resulting concrete, made from these aggregates, has a density of between 85 and 125 lb per cu ft, depending on the particular aggregate used. Providing mixes are so designed as to achieve relatively high cube strengths, it can be seen that there can be considerable savings in dead load by using this type of concrete in preference to a dense concrete (of density 144 lb per cu ft) for some structural purposes. Although very useful in some circumstances, the impression should not be gained that light-weight aggregate concrete will replace the more familiar dense concrete, as there are obviously some disadvantages in its use.

This book is written in a very readable style and the author has the rare knack of keeping his explanations as simple as possible. It is well illustrated with clear neat drawings and tables.

R.C.G.

DATA AND FORMULAE FOR ENGINEERING STUDENTS

Compiled by: PROFESSOR J. C. ANDERSON, DSc (Eng), DIC, CEng, FInstP, DOCTOR D. M. HUM, PhD, DIC, PROFESSOR B. G. NEAL, ScD, CEng and DOCTOR J. H. WHITELAW, PhD, CEng.

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 15*s*)

This compilation is included in the reference books of the Engineering Division of Pergamon's Commonwealth and International Library.

The compilers, as alphabetically named above, are respectively: Professor of Electrical Materials, Lecturer in Mathematics, Professor of Applied Science, and Lecturer in Mechanical Engineering at the Imperial College of Science and Technology.

This booklet is intended to cover the needs of a first-year undergraduate course and embraces: Units and Abbreviations, Physical Constants, Mathematics, Statistics, Properties of Limanae and Solids, Science of Materials, Thermodynamics and Fluid Mechanics, Mechanics and Structures, in forty-two pages.

Most of the formulae in the booklet are included in the section on Mathematics, but the compilers rightly warn students that reliance on the use of memorized formulae can in no way replace proper understanding of mathematical methods.

To keep abreast of the gradual change-over in the UK to the International System of units from the FPS British system, still used in some branches of engineering, data is given in both systems and a list of conversion factors between the two has been included.

A pilot edition of this booklet was used at the Imperial College in the 1966–7 Session, and the observations raised on its content, added to other comments made by the examiners for Part I of the examinations of the Council of Engineering Institutions, have been incorporated in this much-modified edition of the original compilation.

F.T.S.

DIRECT CORRELATION OF PHYSICAL CONSTANTS THROUGH TRANSCENDENTAL EQUATIONS

FREDERICK CROOK, MSc

(Published by the author at Grange Place, Guernsey, CI. 16 pp. Price 21*s*)

This paper is an attempt to explain all the observed physical constants mathematically by linking them to the transcendental numbers "e" and "π". It is a bold attempt, but is written in such a way that it is much harder to read and understand than it might have been. There are fourteen tables of various sorts which seem to be spread about the text almost at random.

Various mathematical theorems, such as those of De Moivre and Wallis, are used, but no mention of them as such is made. It is left to the reader to recognize them in the symbolism employed. The very first paragraph of all seems to deny the existence of Stirlings theorem, which states (in the form most apposite here) that, as n approaches infinity, $(n\,!\,e^n)^2 = 2\,\pi.n^{2n} + 1$.

The basic idea is to take the Physical Constants (Avogadro's—Planck's—Newton's, etc. etc.) and, with due attention to the units involved, to combine several of them together to produce a pure number involving only e and π, but devoid of units. Thus the whole paper is aimed at obtaining a purely mathematical concept of the Universe without recourse to particle physics at all. It is perhaps a pity that the author's enthusiasm leads him into being so contemptuous of a great deal of modern physics.

But, despite the above criticisms this is a most interesting (if often irritating) attempt at making a new start in a very complex field. The paper concludes with *calculated* values for some two dozen constants.

A.G.H.B.

ADVANCED ENGINEERING THERMODYNAMICS

ROWLAND S. BENSON, MSc, CEng.

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 40*s*)

This is one of the books in the Thermodynamics and Fluid Mechanics Division of Pergamon's Commonwealth and International Library.

The author, the Professor of Mechanical Engineering, University of Manchester Institute of Science and Technology, qualifies his use of the word "Advanced" in the title by stating that the grade of the text is directed to the undergraduate final-year honours course in engineering. In fact, the body of the text has been included in courses of mechanical engineering at the Universities of Liverpool and Manchester, and for the past three years the original draft of the text has been used by third-year honours students in the Department of Mechanical Engineering, Faculty of Technology, University of Manchester.

The text includes those aspects of chemistry and physics which are now required by final-year students of thermodynamics which were hitherto covered by textbooks written primarily for chemists and physicists.

The six chapters cover: Equilibrium of thermodynamic systems; thermodynamic properties of systems of constant chemical composition; thermodynamic properties of ideal gases and ideal gas mixtures of constant composition; thermodynamic properties of gas mixtures with variable composition; the application of thermodynamics to special systems.

Each chapter contains developed examples of basic relations, without resource to any particular system of units, and a reasonable number of unworked example questions for student use. The answers to the latter and four tables detailing: Polynomial coefficients; ideal gas properties 0–12,000°K; ideal gas heats of reaction 0–12,000°K, and ideal gas reaction equilibrium constants 0–12,000°K, are included at the end of the text.

F.T.S.

GREAT IDEAS IN INFORMATION THEORY LANGUAGE AND CYBERNETICS

JAGIT SINGH

(Published by Constable & Co Ltd, 10–12 Orange Street, London, WC2. Price 42s)

This is the third "Great Ideas" book written by the author and published since 1959. Its predecessors, covering mathematics and modern cosmology, earned him the Kalinga Prize awarded by the United Nations for distinguished scientific exposition and gained for him an international reputation as a writer who can make complex ideas intelligible and interesting to laymen.

The author states that his book is a worm's-eye view of such multi-pronged probes into the nature of intelligence as the available pooled wisdom of the following disciplines can give us at present with the aim of making artificial automata capable of exhibiting somehow the intelligence of their living original: biophysics, biochemistry, neurophysiology and microminiaturization techniques of molecular electronics.

Thus his way of explaining the development of synthetic intelligence begins with an enquiry into the origin of natural intelligence—the human brain—and then covers the derivation of language and communication, the definition of information and the choice of message transmission systems. Thereafter, he deals successively with the theory and use of automatic computers, both analogue and digital; the study of neuron networks as a prelude to the understanding of high-complication, natural automata—the living brains of animals and humans—by describing the work of W. S. McCullock and W. Pitts and Von Newmann; the machines of A. M. Turing, the English logician; intelligence amplifiers; learning machines or perceptrons; game playing and translating machines; and the Uttley machines which are a bid to uncover the mathematical principles underlying the organization of the central nervous system.

Here then—in a 330-paged nutshell—is a summary of the research thought being applied throughout the Western World to construct the "robot" brain and calculator which will provide the information required by the increasing scientific and technological complexities of the present and future.

It is, perhaps, fair to say that the author's "laymen" must need be persons of some intelligence in order to mentally digest his text.

F.T.S.

BASIC ELECTRIC CIRCUITS FOR ENGINEERS

RUSSELL E. LUEG, Professor, Department of Electrical Engineering, University of Alabama, and ERWIN A. REINHARD, Assistant Professor

(Published by the International Textbook Company, Scranton, Pennsylvania. Price $9.95)

The authors have compiled the text of this 350-paged book in a manner they believe will be of service not only to students of electrical engineering proper, but also to those who need to learn some basic theory of the principles of electric circuits as part of their overall training in the fields of engineering science programmes from a systems point of view, business or commerce.

The first chapter defines basic concepts and covers Coulomb's Law; electrostatics; some magnetism; potential difference; power and energy; the parameters of resistance; inductance; capacitance, and the resultant voltage and current values obtained from variation of the factors.

Subsequent chapters cover circuit solutions—mainly by use of the loop current and node voltage analysis techniques; Laplace transforms for solving transient problems in circuit analysis; the use of phasors for steady state analysis of circuits excited with single-phase AC sources; use of analogue and digital computers for problem solution; other network analysis methods including the Therenin and Norton Theorems; two-part networks for systems; three-phase AC and coupled circuits.

The text demands a student mathematical background up to and including differential equations, and is suitable for second- and third-year students of electrical engineering.

F.T.S.

ENGLISH STUDIES SERIES 5
(MILITARY TEXTS)

B. D. GRAVER and K. J. T. HOILE

(Published by Oxford University Press, Ely House, London W1. Price 12*s* 6*d*)

The authors of this paperbacked book record in their Introduction: "This book has a dual purpose: to provide material in English for instruction in, and discussion of, matters relevant to the training of military personnel, and to give intensive English language practice within the context of this specially selected material."

The contents comprise twenty-eight *Extracts* from a variety of military books or papers written by authors of different military ranks and nationalities. According to the nature of their individual text the papers are included in any one of three parts which are titled:

Part 1 On the Battlefield; Part 2 Operations in Retrospect;
Part 3 The Art of Warfare.

Examples of papers are:

Part 1:

Surprise (*The Capture of Mussolini by Otto Skorzeny*) from Charles Foley's *Commando Extraordinary.*

Leadership by the Junior Officer from Desmond Young's *Rommel.*

Part 2:

Arnhem—*The Post Mortem* from Christopher Hibbert's *The Battle of Arnhem.*

Korea—Winter and Refugees from *The Royal Ulster Rifles in Korea.*

Part 3:

A Soldier's Views on Training, by Lance-Corporal S. S. Jones, from the *British Military Review*, Oct. 1964

Infantry—Tank Cooperation, by Captain I. M. Jacobs, from NATO'S *Fifteen Nations* Aug/Sept. 1952.

Immediately following each *Extract* are numbered *Notes* which define the military application of certain selected words or phrases used in the *Extract.* Thereafter the student is left to solve a number of exercise questions based on the *Extract* text and *Notes*, largely based on the "insert the missing word" or "complete the following sentence" principle.

A number of appendices are included at the end of the book and cover usual abbreviations, comparative weights and measures, alphabetic code-words used in NATO, etc., and answers to the exercise questions.

This book would be useful for Army Certificate Education I candidates wishing to improve their vocabularies or to write better essays.

F.T.S.

THE UNIVERSAL ENCYCLOPEDIA OF MACHINES

Translated and adapted from the German original by C. VAN AMERONGEN

(Published by George Allen & Unwin. Price 50*s* net.)

This 600-page volume describes how a whole host of things work. Each description is illustrated by simple, schematic drawings of the "machine, concept or function" explained. There are, in all, over one thousand such drawings. The language of the text and the terms employed, like the drawings and diagrams themselves, are easily understood, direct and to the point.

There can hardly be a subject in the field of technology that is not covered in the encyclopedia and its basic operation described: from the zip fastener to the laser beam; from the formation of coal, fuel oils and natural gas and their present winning and commercial exploitation to the red shift of distant stellar bodies receding from our planet at ever-increasing astronomical velocities; from the typewriter to an atomic power station; from man-made fibres to washing-machines; from helicopters to the farm tractor; from radio activity to a sub-machine-gun; from the Bessemer convertor to the computer and the Juke Box.

In a volume, even of this size and scope, it is not possible to describe more than the basic facts developed to O, rather than A, level standards. It is, however, a remarkable work if treated as an expanded dictionary of the technologic age in which we live and the increasingly more technical Army in which we serve. Even the ptsc officer would find among its pages something new and something of interest and value.

APPLIED HYDRODYNAMICS

H. R. VALLENTINE, Professor of Civil Engineering, University of Newcastle, New South Wales

(Published by Plenum Press of New York / Butterworth & Co of London)

This is the *second revised edition* of the book with the same title that was first published in 1959 and reprinted in 1961, 1963 and 1965 to meet continuing demands by students of engineering, science and applied mathematics.

In its general revision numerous minor changes in text were made, a new chapter on Vortex Motion was added, and the chapters dealing with Standard Patterns of Flow and Conformal Transformation extended to include the Method of Images and its Application.

The text of the first three chapters, dealing with Flow of an Ideal Fluid, Flow of a Real Fluid, Graphical Flow Nets, Numerical Analysis and Experimental Analogies, is suitable for undergraduate lecture courses in fluid mechanics, but the rest of the book, covering Standard Patterns of Flow, Conformal Transformation, Three-Dimensional Irrotational Flow and Vortex Motion, is quite advanced and only suitable for students in honours or final-year graduate engineering courses. It is based on the author's courses of lectures in hydrodynamics presented over the past five-years to final-year and graduate students in Civil Engineering at the University of New South Wales.

The book is hard-backed and the text contained within 300 pages. F.T.S.

MECHANICS OF MACHINES

PETER BLACK, Mid Essex Technical College, Chelmsford

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 55*s*)

To begin a review of this book one can do no better than quote the author's opening comment in the Preface:

"This is a companion to my book on Strength of Materials (or Mechanics of Solids) and has the same starting point, ie about A-level or ONC/OND. I expect engineering students of all kinds, including those sitting the examinations of the Council of Engineering Institutions, to be able to read it from cover to cover (over a period of two years or so) with a minimum of guidance. It is a fat book because it covers a lot of ground, because it contains a large number of fully worked solutions to typical problems and because, for the benefit of the mathematically rusty, no mathematical steps have been omitted."

Welcome additions to the normal subject-matter discussed are two chapters dealing with the science of lubrication, which the 1966 Joust Report on the state of lubrication education and research recommends should now be termed "tribology". These chapters cover friction, types of motions and drives, the theory of lubrication, characteristics of lubricants, the classification of oils, contamination, additives, types of bearing and their use.

The other eight chapters of this hard-backed 536-paged book are devoted to dynamics, periodic motion, gears, mechanisms, balancing, reciprocating mechanism, cams and control —the latter giving an outline only of the principles of feedback, modern control and measurement.

The large number of explanatory diagrams and charts are well drawn and, like the text, easy to read and understand. F.T.S.

SOLDIERS IN THE AIR—THE DEVELOPMENT OF ARMY FLYING

Brigadier P. W. MEAD

(Published by Ian Allan, Terminal House, Shepperton, Middx. Price 42*s*)

Until a few years ago it was still a surprise to many people to know that soldiers flew aeroplanes and have indeed been associated with them almost as long as there have been aeroplanes. *Soldiers in the Air* gives a vivid and colourful account of the long struggle that the British Army followed before they proved and achieved their most basic needs of aviation. The light helicopter is now firmly established as an Army battle vehicle and the author tells through his own experiences how it has reached this stage.

The book contains many references to persons not known in our own Corps but never the less makes extremely interesting reading and should fire the imagination of anyone interested at all in flying. Peter Mead is well qualified to write the book, having been CO of one of the early AOP Squadrons from 1951–53. From 1958–61 he was on the staff of D/LAW at the War Office and from 1961–64 was Brigadier AAC at Middle Wallop. He has thus been at the heart of things almost during the whole formative period of Army Aviation. N.A.F.E.

Technical Notes

CIVIL ENGINEERING

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

THE BEHAVIOUR OF NO-FINES CONCRETE PANELS AS THE INFILL IN REINFORCED CONCRETE FRAMES. This article by L. G. Simms, BSc, AMICE, of the Building Research Station, presents some limited experimental data on the strength of reinforced concrete frames with infill panels of no-fines concrete when subjected to lateral loads. Tests were carried out on two composite frames which were similar in type to those often used in this country in multi-storey construction. A frame of similar construction but without an infill panel was also tested and the results compared. The article discusses the beneficial effects of composite action and considers recommendations for the design of tall buildings subjected to horizontal loading.

THE DESIGN OF CONCRETE MIXES FOR ESTIMATING PURPOSES. The aim of this article by H. Holland of the Central Laboratory, George Wimpey and Co Ltd, is to assist the engineer in making an accurate forecast of concrete quantities. Usually, at the estimating stage only the minimum works cube strength is specified. However, several other important factors, e.g. type and size of aggregate, degree of control on site, must be considered in order to produce an accurate estimate of quantities. This article presents a comprehensive list of these considerations and discusses their relative importance. The article includes mix design charts, compiled by the author, which give the relationship between water/cement ratio, aggregate/cement ratio, workability, cement content and compressive strength, for three sizes of aggregate having three different particle shapes.

BOW BRIDGE FLYOVER. This month's magazine includes a brief description with photographs of the £2.6 million Bow Bridge improvement scheme. This scheme, which involved the construction of a flyover and roundabout, was opened in October. The main contractor for this project was W. & C. French Ltd, to which firm, Major T. Knott, RE was attached while on a Long Civil Engineering Course.

WIND TUNNEL TESTS ON A PROPOSED MOTORWAY. The Lancashire-Yorkshire (Pennine) motorway M62 is intended to link the west and east sides of the country, from Worsley in Lancashire to Lofthouse, on the Leeds-Wakefield road. Part of this motorway will pass over the exposed crest of the Dean Head Clough dam. This article describes the wind-tunnel experiments which were conducted in order to determine the most effective fencing arrangement which will protect vehicles from the strong winds which can be expected.

INDUS BASIN PROJECT IN WEST PAKISTAN. This article is primarily concerned with a description of the work in Phase I of the Indus River Project. However, the introduction to the article provides an interesting review of the project as a whole, including the political factors which led to its inception. Phase I of the project which was inaugurated on 23 November involved the construction of the £150 million Mangla Dam and the associated barrage and link canals.

J.L.B.

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

WINTER CONCRETING OF THE MOSCOW TELEVISION TOWER. A brief account is given of the methods used for concreting this 1,700 ft high tower. To combat outside air temperatures of about minus 4°F, a combination of steam space heating and electrically heated shutters was employed. The system maintained the concrete at temperatures between 54–68°F and achieved concrete strength of 5,400–5,800 lb/sq in at 28 days.

INJECTION ANCHORS FOR SHEET PILE WALLS. Messrs P. W. Proctor, AMICE and C. A. Pequignot, BEng, of Richard Costain (Civil Engineering) Ltd, describe a method of providing ties for sheet pile walls which avoids disturbance of the ground behind the wall. Their procedure is to drill into the soil with a hollow drill-rod. A high tensile steel bar is fed into the shaft and attached to the drilling bit. The hollow rod is then withdrawn as high pressure grout is fed into the hole. Subsequently, the anchorage is tested and walings fixed to the tie bar in normal fashion. The anchorage thus achieved functions not by virtue of the weight of the anchor block but by the bond between the "anchorage zone" and the surrounding soil.

FLOORING FEATURE. The monthly feature deals with Flooring. A. A. Lilley, Esq, AMICE, AMInstHE, of the Cement and Concrete Association deals with the subject of epoxide resins on surfacings. He considers the advantages, disadvantages and methods of application of epoxide resin paints, self levelling mortars and trowelled mortars. He points out that epoxide resins do not provide the cures to all possible faults but that they are an *addition* to the available methods for tackling some of the problems which occur in industrial flooring. In particular epoxide resins are not resistant to all chemicals.

Professor W. T. Marshall, BSc, PhD, MICE, of the James Watt Engineering Laboratories, the University, Glasgow, discusses the adequacy of the Code of Practice specifications for deflections of floor slabs. He suggests that, whereas the specified deflections were seldom approached 30–40 years ago, present day design practice results in deflections much nearer the specified limit. He notes that practice has changed since 1937 while the permissible limit of deflection has changed only from 1/325 × span to 1/360 × span. (It is interesting to read that Professor Marshall can suggest no theoretical justification for either figure.) The author considers the effect of the permissible deflection on partition walls and concludes that the revised Code should give more adequate guidance on the problem.

The feature is concluded with an article by G. B. Godfrey, Esq, AMICE, AMIStructE, Technical Director of the British Constructional Steelwork Association in which he describes some of the uses of rolled steel sections and concrete as a composite material. He illustrates his article with examples of Preflex beams, steel used in combination with prestressed concrete, open web joists, steel stanchions and flat slabs, and steel decking. In particular the author claims that steel decking, although at first sight an expensive form of construction, can produce very real economies when savings in time and other materials are taken into account.

J.D.W.

THE MILITARY ENGINEER

NOVEMBER–DECEMBER 1967

IAGS PROGRESS IN LATIN AMERICA. This article, by Colonel D. B. Conard CE, describes the purpose, activities and accomplishments of the Inter American Geodetic Survey. This organization was set up in 1946 in order to produce maps of the 8,000,000 square miles of Latin America which was then probably the most poorly mapped territory in the world. The United States sponsored the organization and invited all the Latin American Nations to join in this co-operative mapping programme. The British, Dutch and French Governments also co-operated in respect of their colonies and territories. The main purpose of producing comprehensive maps of Latin America was, from the US Army's point of view, for hemispheric defence purposes. The IAGS is manned mainly by civilian surveyors but it includes sixty-nine military ranks.

AIRMOBILE ENGINEER SUPPORT FOR COMBAT. The authors of this article, Major G. A. Schneebeck and Captain R. E. Wolfgram describe, in a mainly factual article, how use was made of heavy lift helicopters and heavy transport aircraft to fly in the heavy plant of 8th Engineer Battalion in order to construct Dusseau Airfield in Vietnam.

STRUCTURAL PROTECTION AGAINST EXPLOSIVES. Extensive research and development programmes are under way in the United States to establish procedures for design of buildings required to resist the blast effect of explosions. E. Cohen and N. Dobbs, the joint authors, describe the results of these experiments and include in this article photographs and drawings of various reinforcement cages found to be particularly effective in Reinforced Concrete structures.

FOUNDATIONS IN EXPANSIVE SOILS. By Lieut-Colonel J. T. Gafey. Some of the most troublesome soils for construction are the so-called expansion soils, ie, those which swell when moisture content is raised. The worst are dark clays which are common in many parts of the world. It is normal practice to remove these soils before any form of construction is attempted. The author gives an explanation for this swelling effect and suggests possible methods of designing deep foundations to make use of the passive layers of the material at greater depths.

ALUMINIUM IN MILITARY EQUIPMENT. This article, by J. A. Demmler, describes various types of AFVs and other military equipment in the construction of which light alloys are extensively used and the advantages which resulted from its use in this equipment.

THE TWIN DELAWARE MEMORIAL BRIDGE. This article is of interest to Civil Engineers as it describes the method of construction of this 2,150 ft suspension bridge which is due to be completed in mid 1968. The bridge is made of steel and is very similar in many respects to the Severn Bridge. The method of spinning the cables was the same system as in the construction of this latest British suspension bridge. The article is written by W. J. Miller.

QUARRYING IN THAILAND. Those Sappers who were involved in Operation Crown will find this article by Major J. M. Daugherty of interest as the US Army Engineers encountered similar problems in winning, crushing and transporting stone for construction work in Thailand.

EVOLUTION IN CONCRETE DAMS. This article, by D. E. Hallmark, gives a brief history of the development of design and building techniques in the construction of concrete dams through the ages. The examples quoted are mainly dams constructed in the USA.

R.C.G.

G. PERCY

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