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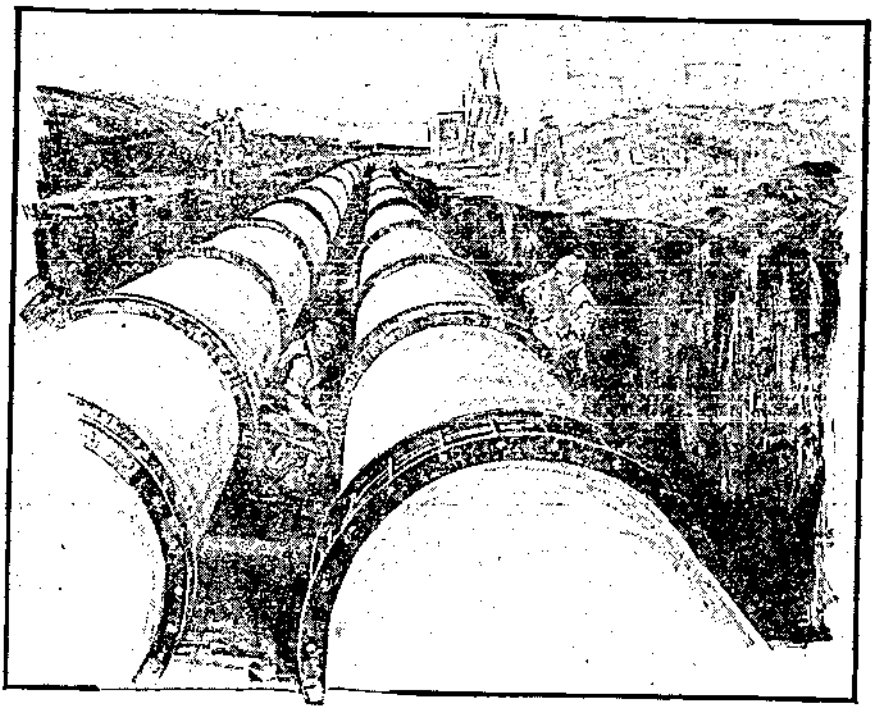

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VOL. LXXXI

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SEPTEMBER, 1967

The Engineer-in-Chief's Address to the Annual General Meeting of the Corps of Royal Engineers on 28 June 1967

INTRODUCTION

CHIEF ROYAL ENGINEER and Gentlemen: I do not remember any time when there was such a prolonged period of uncertainty about the future of the Armed Forces as we have had for the last 2½ years. I have no doubt that many of you are hoping that I shall be able to say something definite about how the Corps is likely to be affected by the reductions everyone expects, but I am afraid I shall have to disappoint you.

The Government is hoping to announce next month their plans for the future size and shape of the Armed Forces, and I cannot anticipate that. However, I do not think that the cuts will be very great in the case of the Royal Engineers and we should hardly be going ahead with the formation of a new field squadron, which was planned some time ago, if we expected any quick and violent reversal. That is as far as I can go to reassure you, but there is no doubt that there will be some cuts in due time.

Secondly, you are no doubt wondering about the effect of all this on morale. Of course, this uncertainty has a bad effect, especially among middle-piece officers, but I think that in the Corps it is to some extent mitigated by the fact that the Sapper usually finds himself relatively well placed when seeking a job outside, and also by the constructive and rewarding sort of life we lead. Certainly I can tell you that the morale of all our units is remarkably high, especially in the trouble spots and where really taxing jobs are in progress.

DEVELOPMENT IN GENERAL

The ending of confrontation in Borneo gave us immediate easement in the Far East and helped us to sustain our efforts in Thailand. It was hard to explain to Ministers why a field squadron from home had to go to the Far East contrary to the general stream, and we had a black fear that 34 Field Squadron from 3 Division would not be allowed to go anywhere at all. But it did get off eventually.

None the less, the "exceptional measures" I referred to last year to ease the overstretch in the Middle East were still necessary, and consisted of borrowing, without replacement, two field squadrons in succession from BAOR for six months emergency tours in South Arabia. This was a great success. Both units have done very well and learned a lot about soldiering and engineering, and a rash of BGS medals has broken out in Hameln, which will soon spread to Osnabruck.

With the reduction of overseas garrisons, the first overseas "resident" units to move back to UK will be 33 Field Squadron from Cyprus, going to Longmoor in August, and 7 Field Squadron with the Brigade from Germany, going to Ripon early next year. The rest will mainly be Strategic Reserve Units coming home to roost. However, who can say what fresh crises may arise, and we are still having to "export" units and individuals on unaccompanied tours on quite a large scale.

ORGANIZATION

The United Kingdom. The reorganization of the UK Command Structure will mean the loss of three Chief Engineer Brigadier's posts. In April next year the Chief Engineer Southern Command becomes CE Army Strategic Reserve Command, but the Chief Engineer Eastern will become a Colonel in an enlarged geographical Southern Command due to the loss of TA commitments. We propose that the Commanders of 29 and 30 Engineer Brigades T & AVR shall double up as Chief Engineers Northern and Western Commands.

There will be some changes in the Regimental structure. CRE Airfields and the two airfield squadrons at Waterbeach have already been renamed 39 Engineer Regiment (Airfields), which is a more appropriate title. A new HQ 37 Engineer Regiment will form at Longmoor next year, to embrace 33 Field Squadron from Cyprus and the new Plant Squadron which is to be formed from existing Command Plant Troops. It will be joined later by another field squadron. 12 Engineer Brigade will thus have four regiments under command, plus the regular specialist units.

We are raising this year 8 Field Squadron for 3 Division at Tidworth, to be affiliated to 24 Brigade on its return from Aden. This will give 3 Divisional Engineers their proper scale of three field squadrons.

Airfield Construction. We have continued to give support worldwide to the RAF, and not only with airfield units. Particularly overseas, more flexible use of Sappers is being dictated by operational necessity, which is all to the good. But it only happens in the places, and at the pace, the RAF themselves wish, because it is essential to gain and keep their confidence. I think so far we have satisfied customers.

Resources. As reported last year, the RE Resources Organization in the UK is to be reorganized as a result of the report of the Odling Committee. 1 and 2 ESDs will concentrate at Long Marston by 1 July 1968. The Army Board has, however, reconsidered the location of HQ ESE because of staffing difficulties, and this will now remain at Woolwich, which has some advantages. Considerable efforts have been made to improve worldwide management of engineer stores and equipment by HQ ESE. A firm of management consultants has been engaged to investigate and advise on the means of increasing their efficiency and is due to report shortly. All stocks of engineer stores and equipment are under review, both at home and in overseas commands. As a result of these reviews there will be a considerable reduction in holdings, but probably an increase in activity.

Military Engineer Services. After lengthy negotiations between MOD and MPBW, a DCI has been published defining works responsibilities in war and emergencies, and governing the setting up of Military Works Areas. Chief Engineers now have a basis for contingency works planning.

Professional Attachments. We continue to seek new outlets to give suitably qualified officers professional experience and responsibility.

We are negotiating with the Commonwealth Office for several attachments to projects in the Pacific, and one officer goes to the Gilbert and Ellice Islands this year for airfield work. We are arranging with the Ministry of Transport for the employment of five officers, at three different levels, in the Road Construction Units the Ministry is forming to carry out the big motorway development plan.

The Chief of Engineers US Army generously offered me three vacancies, at Captain or Major level, in his Civil Works Organization, the scale of which is so vast that it offers unrivalled technical and managerial experience. We are most fortunate to have this opportunity, but I can only take up two of the vacancies by sending one officer each year off the Long Civil Course, for a two-year tour. The first officer went over in March.

Snowy Mountains. We continue to have officers attached to the Snowy Mountains Authority in Australia, and I should like here to pay tribute to Sir William Hudson, the Commissioner, who has been so outstandingly helpful to the Corps and to individual officers, and has recently retired. I have written to him on behalf of the Corps.

PERSONNEL

Officer Recruiting. Regular officer recruiting has been improving somewhat. In 1966 we recruited fifty-eight—four more than in 1965, and eight more than in 1964—against a target of sixty-six. We are getting an improved output of non-regulars from Mons and elsewhere, but not enough applicants for Limited Service Regular Commissions.

Under the new system of officer training, which will include a reduced period of only one year at the RMA, Sandhurst, the indications are that we shall get fewer officers into Cambridge through that channel, though we hope more will take the new Shrivenham degree. I am sure that the University infusion is important for the Corps and we are, therefore, examining ways of increasing our University direct entry. This has, in fact, been going up, but we shall need more.

Officer Shortage. The shortage of regular Captains will get worse over the next two years, as the surplus of junior Majors, who could fill some of the slots, is rapidly diminishing. After that, we should see some improvement.

Soldier Recruiting. Recruiting declined a little in 1966, but the Corps strength rose well above the manpower target, largely due to a higher prolongation rate than expected. We are now some 4 per cent over strength, in spite of being fourteenth in priority for uncommitted men. This is healthy, but as we face fiercer competition in the next few years, when boys of low birth-rate years mature, we cannot let up, but must be more selective in whom we accept.

A quarter of our intake comes from Chepstow and Dover, and this is a great source of strength. Apprentice recruiting is difficult at present and Chepstow is only 80 per cent full. But Dover, which is established for 580 Junior Leaders, has at the moment a strength of 588, and this is most encouraging.

Redundancy. Redundancy resulting from cuts in the Reserve Army and in the UK Command Structure has, in the case of the Corps, been slight, and I do not think it will be very serious in the future. There is nevertheless a steady flow of officers and men leaving the Corps because they feel that life outside would suit them better—and they are usually well qualified for it—and this improves the prospects of those devoted to soldiering. I think it is quite a healthy process, provided we get the necessary input.

Unfortunately, as no redundancy terms have yet been announced, it has been hard for some people to decide whether to retire voluntarily, and this has made planning difficult.

EQUIPMENT

General. The initial promise shown by the new range of bridging equipments has been amply fulfilled in that both the Medium Girder Bridge and the Class 16 Airportable Bridge have shown up extremely well on troop trials. A new mine, the Bar Mine, and its associated layer are due in service in 1971. This system represents a great advance in that it is possible to lay a minefield twice as fast as before, with roughly half the manpower and logistic load. Mine detection, particularly the rapid detection of the individual, random-scattered mine, which has caused us so much trouble in South Arabia, remains a major and as yet intractable problem.

Long-term developments go well, but I am afraid that the effect of financial cuts are bound to be felt.

Plant Management. I said last year that a Working Party under Brigadier R. A. Lindsell had been set up to advise on the whole business of provision and management of plant. The "Lindsell Report" was issued in June 1966, and its recommendations have been approved by the Ministry of Defence, including, I am glad to say, those with financial implications, especially the casting policy and replacement programme. It will form the basis of immediate provision and of long-term planning.

At the same time DEME and I have agreed on a proposal for the better conduct of plant repair, which I hope will be approved next month, and I will not anticipate

by giving details. I will say, however, that it provides for co-operative effort, which will be far more satisfactory to both of us, and more effective than the present system. It also ties in well with our current review of the mechanical trades structure of the Corps which is so vital to us. I believe that the combined effects of the Lindsell system and the new repair arrangements will transform the plant scene in the next decade and begin to show results in two or three years' time.

TRAINING

1 Training Regiment. It has been found that 1 Training Regiment is too large to be run to the best advantage as a single unit, and consequently it is to be split again next year into two Lieut-Colonels' Commands, as 1 and 3 Training Regiments. They will both be accommodated at Cove, and later in the new barracks to be built for them and for HQ Training Brigade at Hawley.

Trades. Now that the role of the Corps has become clearer we have been able to take a fresh look at our trades, and it is plain that their balance and content must be kept under continual review to keep pace with the changing size and shape of the Army and the developments in the engineering world. I have, therfore, formed a Standing Committee on RE Trades, with a number of subcommittees dealing with various groups. This is currently very active, and high priority is being given to the mechanical trades, owing to the new proposals for plant repair and our increased works responsibilities.

With increased pressure on manpower, it is essential that we make the best use of the material and facilities available. I am, therefore, intending to set up a small Trades Training Inspectorate as part of my staff to develop trades training policy and methods, and ensure that it is carried out.

Chepstow. The first RE Commandant of the Army Apprentices College has been selected and will be in post next year. It is to remain a Corps appointment.

SURVEY

Topographic troops have been deployed in Borneo, Arabia, Cyprus and Germany throughout the year on tasks undertaken on behalf of the three services. Additionally, surveys were carried out in the UK and Eire. One Major and two NCOs were sent to demarcate the Argentine-Chile border.

A (Geodetic Satellite Survey) Specialist Team, comprising an electronic and an optical tracking section, has been formed in support of the American Satellite Tracking operations. The sections are engaged on quite separate but interrelated geodetic projects and both are currently working in the Hawaiian Islands.

A large number of new maps and air charts, at varying scales, have been produced. Of particular significance was the production of the first seventy sheets of the new 1:250,000 Joint Operations Graphics map series which have been taken into use by troops serving in South Arabia and the Far East.

BOMB DISPOSAL

The Bomb Disposal Unit has had another exceptionally busy and successful year and has disposed of more unexploded bombs than in any year since 1953. Clearance work has also been continuing steadily overseas, and the high spot of the year has been the award of the George Medal to Major H. P. Qualtrough and to Sergeant H. E. Cooke for their gallant part in the clearance of dangerous Japanese ammunition dumps in Penang and of dumps on Betio Island in the Pacific.

POSTAL AND COURIER

The Forces Postal and Courier Communications Units have continued to provide a worldwide service to the Royal Navy, Army and Royal Air Force. In addition to normal commitments they have also provided exercise support in Canada, Italy, Norway, Denmark and Dominica, and operational support is currently being given to the Royal Navy in the Beira Straits.

A large proportion of Field Post Office counter services result in the earning of considerable amounts of much-needed foreign currency.

In July 1966 Post Office Saving Bank facilities were extended to families and civilians in Germany.

ACTIVITIES

I will now give a short account of some of our activities round the world, starting at home.

UNITED KINGDOM

Strategic Reserve. Units of the Strategic Reserve, when not on emergency tours overseas, as many have been, were fully committed as usual on training exercises and other tasks at home. One of many taks last year was an airfield built at Plockton in Scotland, and this year another has been started at Unst in the Shetlands. The Upnor-Chattenden road is occupying a succession of units and should be finished by the end of the year.

Reserve Army. One of the major events of the past year has been the disbandment of the AER and TA, and its replacement on 1 April 67 by the new T & AVR. To mark this occasion, the Corps invited to dine in the new mess at Chattenden all the Honorary Colonels and Commanding Officers of the RE Reserve Army units. Nineteen Honorary Colonels and representatives from forty-one disbanding units attended. The Chief Royal Engineer in a memorable speech thanked them on behalf of the Corps for all their distinguished services in the past, and wished the new T & AVR units well for the future.

The "Independent" units, the successors of the old TA, are mainly located in the West and North, and are grouped in two brigades, 30 with HQ at Stafford, and 29 with HQ at Edinburgh, but due to move to Newcastle. The non-brigaded units are the BD Specialist Team at Rochester, 131 Parachute Squadron, with HQ in London, and the Survey Squadron at Ewell. These units are getting into their stride and are fairly well recruited. Nearly all of them are camping in the UK this year, but from next year we hope to get them overseas camps every third year, and far more interesting and higher-level training than of old.

The successors of the AER are the "Sponsored" units and, like them, are drawn from all over the country. They include a resources squadron, a reduced number of specialist teams, postal units, a pool of specialist officers and 111 Engineer Regiment with two squadrons. I was pleased to see when visiting this Regiment in camp at Ripon that a number of officers and other ranks from the disbanded TA Regiments in the South were happily integrated. Some have also gone into the specialist teams, but we did not have room for as many as we should have liked. Two of the specialist teams have already been to South Arabia for their annual camp, and others are due to go to Singapore, and Cyprus later this year.

The RSME. The new Chattenden barracks were opened officially on 9 November 1966 in the presence of a distinguished gathering, and the Chattenden Officers' Mess has been carrying most of the Corps functions. The rebuilding at Brompton, and the refurbishing of the HQ Mess and HQ RSME should be complete by the end of the year, when we can return to normal and enjoy all the first-class new facilities provided there, including the new Technical Training Group and Workshops, which are already partly in use.

The RE Demonstration was held on 9 and 10 May last, the deafening climax being the take-off and landing of the P1127 Harrier at Upnor Hard.

BAOR

The Defence Review will result in the return to the UK of a field squadron as part of the withdrawal of a brigade and, apart from this and the loan of squadrons to the Middle East, there has been very little difference in the pattern of life in Germany in the last year, except for a spate of planning by the staff to save Deutschmarks. Nearly all field squadrons are now equipped with APCs and 1 and 2 Divisions have RE Helicopter Flights.

Although the loan of units to Middle East was hard for BAOR, they have done everything possible to make it a success, including some preparatory training and posting up, at the expense of their own needs, thus greatly easing the task of the Chief Engineer Middle East. This experiment has shown once again that the same units can perfectly well operate tactically as combat engineers or get down to a construction project, with a little specialist assistance, at short notice and with efficiency in both roles.

MEDITERRANEAN

Cyprus. Things have continued much as last year. An aerial farm with 150 ft towers, and ski lifts in the mountains, have figured among a large number of projects. But it has been found more difficult to provide the required support for UNFICYP, and a proposal has now been made for an RE detachment to accompany the infantry battalion on roulement.

33 Field Squadron is to be withdrawn soon, leaving a CRE and a composite squadron containing both field and park elements. This squadron will serve the Army and RAF and will have an airfield construction capability.

Malta. Earlier this year the future of Royal Engineers Malta was very much in doubt. They seemed likely to be disbanded, but they have had a reprieve and we can expect a new lease of life until about 1970. They have carried out tasks in Cyprus and Tobruk, as well as in Malta itself.

Gibraltar. The last tunnel likely to be built by Sappers will be finished by September. The tunnelling troop of the 1st Fortress Squadron will have been run down by next year, and the historic trade of Tunneller will disappear from the Corps. Operation of power stations will continue, as this gives indispensable training for our E & M tradesmen.

MIDDLE EAST

The Middle East, as ever full of interest and incident, continues to provide challenges for Sappers, pleasant and unpleasant. Besides support for the Aden Brigade in anti-terrorist operations, which has been very considerable, road construction, airfield development, well-boring, irrigation and various forms of civil assistance upcountry have continued. 523 Specialist Team (Construction) has undertaken the building of permanent barracks for the Federal Army in five stations, as well as all service works upcountry on behalf of the MPBW and the Federal PWD. There have also been minor tasks in Abyssinia, Zambia and Malagasy, and works in the Persian Gulf.

The building of the Lahej-Habilayn and Habilayn-Wadi Taym roads has now been completed. Their black-topping has greatly reduced the incidence of mining, but there have been continual attacks on men and plant, sporadic mining and damage to culverts. A great deal of flood damage has been made good. The Aden-based units have been supplemented by squadrons in rotation from the UK and BAOR. All have done magnificent work, and their low rate of casualties is a reflection of good discipline and tactical training. In spite of this, a construction party from 39 Field Squadron from BAOR, moving tactically in the Wadi Matlah, recently encountered a severe ambush, in which two sappers were killed and one officer and eight sappers wounded. However, they acquitted themselves well. The officer, though wounded, quickly organized counteraction, called in air support, and a successful action against the ambush position ensued.

In April the combined effect of a general strike due to the arrival in Aden of the UN Mission and a phenomenal flood put a large part of the public utilities out of action. The Sappers played a major part in restoring them, working often in disgusting conditions, cheered on by the odd grenade. There is no doubt how much their efforts were appreciated. A number of specialists were sent out as emergency reinforcements, and although these are now back, we are quite expecting to have to send many more before we are through.

Redeployment to the Gulf has involved us in building a camp in Bahrein for the MPBW. This was done by 24 Field Squadron from Maidstone, assisted by 524 STRE (Construction) and they finished in May, four months ahead of schedule.

There now remain only a few specialists and tradesmen helping the MPBW in Bahrein and Sharjah.

FAR EAST

The withdrawal of British, Commonwealth and Gurkha troops from Borneo was complete by early this year, except for a small presence in Brunei State, which includes a Gurkha field squadron engaged on road development in the Temburong District. The withdrawal went smoothly and CRE Borneo became CRE (Ops) FARELF.

All the Sappers in Borneo, British, Australian, Gurkha and Malaysian played an indispensable part in what was truly a great feat of arms. Satisfaction at this success, and at the lasting benefit our roads and airfields will be to Borneo, is tempered by regret at the loss of such a splendid training ground for junior officers and NCOs.

The airfield project at Leong Nok Tha in Thailand, Operation Crown, has had its ups and downs, ending with a big "up". I told you last year that the original design did not fulfil its promise and in 1966 we superimposed an 8 in layer of PQC concrete to turn it into a permanent airfield. This operation was an outstanding success. In spite of many real difficulties, some inherent and some quite exceptional, such as the record flooding of the Mekong, the project was finished on time by the end of the year to a quality well above specification. This reflects the greatest credit on all engaged, who worked with tremendous enthusiasm, and especially on the CRE. The FARELF units were relieved in October by 34 Field Squadron on a six months' tour from Tidworth. After finishing the airfield, they started on Post Crown, a programme of feeder-road development to link inhabited areas, and part of a larger scheme to open up this very poor part of Thailand which is much subject to Communist subversion. They started in January, and by the end of April the first 13 km were officially opened amid great local rejoicings. We hope to complete 25 km by the end of the year. I also hope that further units, including another from UK, will be allowed to continue into 1968, but this will be a political decision. Post Crown is financed partly by the Thai Government and partly by the Foreign Office.

The rundown of the Brigade of Gurkhas by a third will mean the loss of one of our three Gurkha Field Squadrons by the end of 1968. This will be 69 Squadron, raised only just before the Borneo confrontation, in which it took a valiant part and for longer than any other unit in the Army. All three squadrons will run down to two troops by the end of next year, and the remaining two of 69 will then transfer to 67 and 68 Squadrons. Thus the field-troop structure, which means so much to the Gurkha Sapper, will as far as possible be preserved. You will be interested to know that Gurkha Captain Sherbahadur Limbu, the latest recipient of the Durand Medal, is in this country serving as one of the Queen's Gurkha Orderly Officers.

CONCLUSION

The tendency to close down or reduce our bases overseas makes it necessary to enhance the construction capabilities of the Corps, and to do this we must have overseas projects. There is no doubt about the immense value in training and morale that we have derived from rotating units through such projects as Christmas Island, and more recently projects in Thailand and the various construction tasks in the Middle East.

The drift of units from overseas back to the United Kingdom makes it even more important to obtain such projects, both for training and to maintain enthusiasm and morale, and it is necessary to look beyond purely military requirements.

First, there is what we call "Engineering for Peace", of which Post Crown is an excellent example. We have seen in Malaya, and elsewhere, how enormously prosperity can be increased by such methods, and how subversion can be defeated before

it gets out of hand. The presence of Sappers can, and does, generate enormous goodwill without political embarrassment and with big political and military dividends at low extra cost.

Then, there is Overseas Aid in general, making the funds available for overseas development go farther. This means, in effect, that the Ministry of Defence has to tender for work to the authority concerned. We are now carrying out a pilot exercise on these lines which is going well, and which I hope will lead to a good project next year, and more to follow.

There is a certain amount of scope in the United Kingdom, though for various reasons tasks in this country usually have to be rather limited in size and duration.

All this is quite in line with the policy referred to by the Secretary of State in the last White Paper on Defence, to the effect that the Services should undertake more tasks for the benefit of the community, to give them more worthwhile and interesting training and to improve their public image. Clearly the Corps has a big part to play in all this.

For these reasons, though we are gradually losing a number of overseas family stations, I see in the future a great deal of movement on projects and operations and no reason for a young man not to expect variety, travel and constructive achievement, besides soldiering, in his Sapper life. I believe it is our ability to offer this which accounts for our present overstrength in spite of low recruiting priority, and for the ever-rising quality of the Sapper.

I hope you have got the impression from what I have said that the Corps is in good shape. I am not an unbiased witness, but I really think it is. There is an atmosphere of competence and seeking for challenges which I find most exhilarating.

CHIEF ROYAL ENGINEER

This is the last occasion on which General Sir Frank Simpson will preside over this meeting as Chief Royal Engineer and I take this occasion to express to him on behalf of the Corps our gratitude for all he has done for us during the past six years, for all his wise guidance and example and for all his personal kindness and warmth which so many have felt, not least myself in this office. We wish you, Sir, all the happiness you have so ably and so nobly earned. The Corps will not forget.

Presentation of Doors by Royal Canadian Engineers

THE main doors of the Study Centre, Chattenden Barracks, a gift from all ranks of the Corps of Royal Canadian Engineers, were formally presented to the Royal School of Military Engineering by Lieut-General L. G. C. Lilley DSO, CD, at a simple ceremony on 15 May last.

General Lilley is a previous Commandant of the Royal Canadian School of Military Engineering, a graduate of the Imperial Defence College and now Chief of Technical Services of the Canadian Defence Forces and their senior serving "Sapper". He was accompanied by Brigadier J. E. Melville, CBE, MC, ED, CD, a veteran of the First World War and one-time Chief Engineer, First Canadian Army, in the Second. For the last twenty years he has been Colonel Commandant, Royal Canadian Engineers.

The doors were accepted on behalf of the Corps by General Sir Frank Simpson, GBE, KCB, DSO, Chief Royal Engineer.

The Presentation Ceremony was held outside the Chattenden Study Centre. Lieut-General Lilley, accompanied by the Chief Royal Engineer, inspected a Guard of Honour furnished by 12 RSME Regiment, commanded by 2nd Lieutenant R. H. O. Hayward, RE, and then in his speech of presentation Lieut-General Lilley stressed the long-cherished, close fellowship between the Canadian and British Sappers, and referred to the many RMC Kingston Cadets who in the past had been commissioned into the Royal Engineers and the present-day slight trickle in the opposite direction. The doors, he explained, had been designed by an architect of Tribe and Wakeham, the Architects of Chattenden Barracks, fabricated by Sapper tradesmen at the Royal Canadian School of Military Engineering, and flown to England by the Royal Canadian Air Force. After the Chief Royal Engineer had thanked all ranks of the Canadian Sappers for their splendid gift, Lieut-General Lilley unveiled a plaque above the doors to a fanfare sounded by Royal Engineer Trumpeters. The inscription on the plaque reads:

Presented on 15 May 1967 to
ROYAL SCHOOL OF MILITARY ENGINEERING
By Lt-Gen L. G. C. Lilley, DSO, CD
Senior Serving Canadian Sapper
On behalf of all ranks
CORPS OF ROYAL CANADIAN ENGINEERS

After the presentation Ceremony a description of the functions of the Royal School of Military Engineering was given in the Study Centre.

At the lunch which followed in the Chattenden Officers' Mess the pride of place among the many silver centrepieces which graced the table was given to the Royal Military College, Kingston "Arm", presented to the Royal Engineers Headquarters' Mess at a Guest Night, held on 18 November 1965, by the surviving ex-Cadets of the Royal Military College of Canada to commemorate the regular service of the 125 Canadians commissioned into the Royal Engineers between the years 1880 and 1942. The illuminated scroll containing their names was also on display.

Among the Canadian officers who attended the Presentation with their wives were Brigadier D. W. Cunnington, Commander of the Canadian Defence Liaison Staff, London; Major D. M. Youngson, the Canadian Engineer Liaison Officer; Major D. F. Edie, employed in the Ministry of Defence; Major J. L. McDougall, serving with 42 Survey Engineer Regiment; Captain W. L. Wharton, Instructor in the Field Engineering School RSME, and Lieut-Colonel J. Van Doornick, who was in attendance on Lieut-General Lilley.

Photo 1. Lieut-General Lilley unveils the plaque

Presentation Of Doors by Royal Canadian Engineers 1

Photo 2. Brigadier W. M. Inglis, Commandant RSME, Brigadier J. E. Melville, CBE, MC, ED, CD, Colonel Commandant RCE, Lieut-General L. G. C. Lilley, DSO, CD, and General Sir Frank Simpson, GBE, KCB, DSO, Chief Royal Engineer

Presentation Of Doors by Royal Canadian Engineers 2

Mr J. H. Broome, who designed the doors, was also present.

Amongst the serving and retired Sapper officers attending with their wives were Major-General C. G. Woolner; Brigadier J. C. Woollett, Deputy Engineer-in-Chief; Brigadier W. M. Inglis, Commandant RSME; Brigadier E. F. Kyte, Chief Engineer Eastern Command; Brigadier J. H. S. Lacey, Secretary Institution of Royal Engineers, and Brigadier J. G. Carr, one of the 125 Canadians commissioned from Kingston into the Sappers and who when Commandant RSME was largely responsible for the procurement of the RMC Kingston silver centrepiece and the scroll which, as Major-General G. S. Hatton said when presenting both to the Chatham Mess, contains the names of "those who were a credit to the College from which they came and to the Corps in which they served".

The Place of the Engineer in the Development of a Country

The text of a recent address, delivered in Montreal to the Congress of Canadian Engineers, by the Lord Hinton of Bankside, KBE, FRS, Deputy Chairman the Electricity Supply Research Council, and reprinted with his kind permission.

EVEN remembering, as I am bound to do, the time limit that you have set for me, I must first say how honoured I am to give the Opening Address at this Congress of Canadian Engineers. I believe that this is the first time the the Professional Engineering Institutions of Canada have all come together in a meeting; engineering has many branches but it is one single profession and its unity is important. We in the United Kingdom are seeking to achieve this unity through the recently formed Council of Engineering Institutions.

Your purpose in this coming week is to look forward at the next ten years, but the past is the prologue to the future and the future cannot be separated from the past. You can look forward to a great future for Canadian Engineering because you are made worthy of that great future by your engineering achievements of the past century. In the development of hydro power, in the transmission of electricity and in the development of electro-chemical industries you have led the world. In bridge building, in dock, harbour and canal works, in the mechanization of farming and in atomic energy Canada has been among the leaders; the story of the construction of the Canadian Pacific Railway is one of the great epics of engineering. Wise statesmanship made Canada into a united country, but the links which made that unity possible were fashioned by engineers.

Those engineers were, generally, men who had learned the art of engineering in the hard school of practice. They had less theory than is now taught to professional engineers, but, in an industry that was then less sophisticated, they were able to dominate the great works that they undertook. Those times produced great engineers and it is a loss to engineering that fewer men now face the great physical and mental challenge that moulded these earlier engineers into greatness. But engineering has become more complex and few engineers today are dominant, autocratic dictators of great projects; they are more often members of a team made up of people trained in many disciplines. If (as is happening in the United Kingdom) engineers complain of

loss of status, it is to some extent because they have failed to grasp this and have failed to realize first that both credit and responsibility must be shared, and secondly that knowledge of the techniques of engineering does not, in itself, qualify a man for leadership of the teams which are responsible for engineering projects.

The position of the engineer in industry has changed and only realization of what has happened and what is happening will enable him to take his proper place. To carry out great projects today an engineer must work with and sometimes work for men trained in many disciplines other than engineering—with scientists, financial experts, economists and others.

In its earliest days engineering was empirical; the steam engine was developed at a time when the nature of heat and the relationship between heat and work were not understood; the sand filter (which did so much to reduce the death-rate) was designed to remove inanimate solids from drinking water; it was not expected that it would remove most of the bacterial content and years passed before the reason why it does so was understood. If in those earlier days scientists, as such, were called in, it was usually to explain the failure of an engineering project; Torricelli discovered the nature of atmospheric pressure because the engineers of Cosimo dei Medici failed to build a suction pump capable of lifting water from a depth of 50 ft and the problem of their failure was referred to Galileo whose pupil Torricelli was.

The changed relationship between engineering and science started to develop about the middle of the nineteenth century, yet at the end of that century Sir Charles Parsons said that mathematics had played no part in the development of his steam turbine. It is only in recent years that research departments have begun to be regarded as what they should be—namely, the intelligence and reconnaissance units of the great army of engineering. The change in relationship started when the growing complexity of industry, its increasingly competitive rate of advance and its growing sophistication made it impossible for engineers both to evolve and to apply new scientific and technological knowledge. But there is no doubt that the Second World War did a great deal to show to industry how scientific research could be used both as the foundation for new engineering development and to accelerate developments that were already being made. The fallout from defence research was and is widespread. Not only did defence work in the field of atomic energy lead to the development of nuclear power, it demanded and fostered research in ion exchange, fluorine chemistry, vacuum technology, the metallurgy of a wide range of metals, the development of digital computers and other things, and this is typical of all great defence developments.

The war taught industries that were not research minded that research could be useful and it made research fashionable. But fashionableness and usefulness do not always go hand in hand and I doubt whether engineers as a whole can claim that they have achieved that close collaboration with research which is necessary to derive full benefit from it. In most of the process industries the position is fairly satisfactory, but that is natural, because, in those industries, many of the "managers" have the same educational background as the "scientists". In the "new" technologies, such as electronics, space travel and atomic energy, collaboration is also good, because in these industries there is no alternative to close collaboration. Of all the industries in which I have worked it was only in atomic energy that I was satisfied with the relationship between research and engineering; there the engineers realized that they could not be expected to know the answers to many of the problems that faced them—they didn't "lose face" if they had to ask the scientist. The scientists on their side recognized the fact that they couldn't be expected to have the answers to all the questions that the engineers asked—they had no pinnacle of superior knowledge on which to pose. Conditions like this make it possible to build organizations in which scientists and engineers work together as an integrated team.

But I doubt whether many of the traditional engineering industries can claim this sort of collaboration. The lack of it can, I think, be attributed to three things: first, a self-satisfied belief among many engineers that they should be the principal

arbiters of when and how scientific knowledge should be applied and an unwillingness among them to accept techniques which are new to them, but which have been well established by research or by use in other fields; secondly, an unwillingness on the part of scientists to share responsibility with the engineer for the results of advice that they give and that engineers accept; and thirdly a familiarity with established processes which blinds those who are concerned with them to their lack of fundamental knowledge.

With the first of these reasons one is bound to have some sympathy; all engineering progress is a gamble in which one balances the risk of advancing into the unknown against the financial benefit to be achieved by acceptance of that risk. But the degree of conservatism that is shown is sometimes unjustified. The design of bearings for large turbo-alternators is an example of this; in British turbine practice the general trend towards the use of bearings having low length to diameter ratio, high specific loadings, thin shells and small clearances has not been followed, although the advantages of this trend are well established by research and by use in aircraft practice. Turbine bearings still use length to diameter ratios of more than unity, although, with increasing size, problems such as high starting torque, high bearing temperatures and vibration have been met. The loss by bearing friction on a 500 mw set is expected to be about 1 per cent and this corresponds with a fuel cost of about £30,000 a year. With greater foresight and greater flexibility of mind, I am sure that it would have been worth while to accept the risk of keeping pace with developments made in other fields of engineering.

To support my second point I can only say that, except in the first ten years of atomic energy, I can remember very few cases in which a scientist was willing to come forward and lift the responsibility for a failure which resulted from his advice from the shoulders of the engineer who had accepted that advice.

My third point was that familiarity with established processes blinds those who use them to their ignorance of what is happening; I am going to give two examples of this.

Fossil fuels have been in use for a century or more and more power is generated by burning fossil fuels in boilers than in any other way. Yet today we know more about what happens inside the fuel element in a nuclear reactor of which we have ten years' experience than we know about what happens to a particle of pulverized fuel or a droplet of oil in the combustion chamber of an ordinary boiler of which we have a hundred years' experience. The value of complete knowledge of the fundamental chemistry and physics of combustion of fossil fuels in boilers is very great, yet systematic work on the fundamental science has only recently been put in hand; familiarity with the process blinded users to their ignorance of it and to the need for such research.

My second example is in the milling of pulverized fuel. In the United Kingdom about 70 million tons of coal are pulverized each year at a cost of at least £7 million. Yet we do not know how much of the power supplied to the mill is theoretically needed to pulverize the coal (it is probably less than 15 per cent), we don't know the effect of ash and volatile content on grindability, we don't know how to avoid over-milling some of the coal and we don't know the optimum spectrum of particle size in the product. The problem has simply grown on us and we have failed to foresee the value which a complete understanding of it would have.

Looking forward, then, over the next ten years I suggest that the first thing which is necessary is a closer relationship, better understanding and greater mutual respect between scientists and engineers. To achieve this must be the responsibility of higher management. I have already said that research and development should be to industry what the intelligence and reconnaissance units are to an army. It is the responsibility of the higher command to see that both strategy and tactics are based on the intelligence information which is available.

In the days when single individuals such as Whitworth, Mond or Parsons could build up and dominate industries this need for close collaboration with scientists was

not necessary, and it was equally unecessary for them to be guided and sometimes controlled by economists and financial experts, as most engineers must now be. The discipline of finance must ultimately control all engineering; when I was directly in charge of large industrial organizations I made it a rule never to accept the practicability of proposals made by scientists until they had been evaluated by engineers and never to accept the engineers' estimate of profitability until it had been checked by the accountants.

It is difficult to make engineers realize that time is money and that savings made by early completion of a job may far outweigh those that would arise from achieving the greater engineering sophistication which could be obtained by taking more time in the optimization of design. In the United Kingdom we take far too long to build new power stations and, in my Citrine Lecture to the British Electrical Power Convention in 1965, I pointed out that "The Central Electricity Generating Board have about £M 750 locked up in capital work in progress and a return of 12 per cent must be earned on this money though the works on which it has been spent are earning no revenue. If construction periods were shortened to what is known to be achieved in other countries the Board would save £M 15 a year." But they would do more than this; the present construction period makes it necessary to plan on the basis of load forecasts which are projected six years into the future; the shorter construction periods which are achieved elsewhere reduce the forecasting period to four years and so give far less room for error.

One of the dangers which arises from the extensive theoretical training which is now given to engineers is that it encourages them to make a fetish of technological perfection and to forget the value of time in their optimization. Economists and financial experts find their place in the industrial team because technology, time and money are inseparable in industry and money is the only yardstick for measuring industrial success.

It is because of the need to teach these men, trained in different basic disciplines, to work together that so many Business Schools and Schools of Management have been established in recent years. You in the American Continent have set a pattern for this training and I am sure that it is a good one. I sometimes feel, however, that Schools of Management teach the young engineer techniques which are considered to be sophisticated without first teaching him two simple basic principles. The first is that management is the art of creating organizations in which *other people* can work fruitfully; the second is that men and women will not work fruitfully and happily unless each one of them is made to feel that he or she is important as an individual. To teach sophisticated techniques of management without first teaching these basic principles is like giving instruction in power-plant design to a student without first teaching him to understand the laws of thermodynamics.

I have already suggested that research and development organizations can be thought of as the intelligence and reconnaissance units of the engineering army; the accountants and economists perhaps represent the civilian restraints of finance and supply. But what of the army itself? It consists not merely of the professional engineers who are its officer corps but also of the far more numerous technician engineers working under them and of the artisans who form the base of the organizational pyramid.

The training of engineers is now very different from what it was when I started to do engineering fifty years ago. In those days it was normal for boys to go straight from school to apprenticeship from which, if they were good enough, they progressed to the drawing office and from there, on merit, they were promoted to management. Today the boy who aspires to be a professional engineer in the United Kingdom is likely to get a university scholarship when he leaves school and either to serve a short apprenticeship after graduation or to take one of the sandwich courses run by the newly formed technological universities. The school-leaver who starts an apprenticeship and gets his theoretical training by part-time study will find it increasingly difficult to rise to the professional ranks. Thus the development of the British

educational system is creating a line of demarcation between professional and technician engineers which did not exist in the past and the Council of Engineering Institutions (moving, as it must do, with the educational tide) has set up academic criteria of qualification for professional engineers which emphasize this line of demarcation.

The engineering profession must realize the seriousness of the problem which has been created. For every professional engineer there are at least four technicians and they are as important as the non-commissioned officers in an army. In the United Kingdom there are at present no recognized standards of qualification and training for technician engineers and they are not satisfactorily co-ordinated by institutions or societies. What we need is a Florence Nightingale of engineering; Miss Nightingale's great achievement was that she made nursing (which is the main technician grade of the medical profession) respectable in its own right. We need to create the same sense of pride in the work of the technician engineer—it may not demand the same originality of thought or the same powers of theoretical analysis as should be expected of the professional engineer, but, just as the nurse is closer to the patient than the doctor is, so the technician is closer to the practical problem than the professional engineer and he should take joy and pride in this. We must be careful that the technician engineer is never thought of as a second-grade citizen, and there is some danger that this may happen in the United Kingdom if nothing is done to establish his position.

At the base of our engineering pyramid we have the artisan. When I was serving my apprenticeship in the old Great Western Railway shops at Swindon we used to build locomotives, take them out on a trial run at forty miles an hour, bring them back at sixty and send them straight to the running sheds. I thought we could do this because those engines were beautifully designed. But after the First War the Government replaced engines that had been requisitioned for use in France by locomotives that had been built to standard Great Western designs by contractors. These engines used to be delivered to Swindon, go out on trial and limp back to the erecting shop; we used to strip them down and partially rebuild them. The perfection of our Swindon engines depended not on good design alone but rather on good design combined with good craftsmanship, and this is true of all engineering.

In recent years craft training has been neglected in the United Kingdom except in isolated cases. In the old days individual craftsmen took pride in training the apprentices who worked with them, but this spirit has largely disappeared; in some firms (mainly the large ones) it was replaced by apprentice training organizations, but only a small percentage of engineering firms were doing enough apprentice training and doing it satisfactorily. Three years ago the Industrial Training Boards were set up to ensure that all firms did their fair share of training and did it satisfactorily. The Boards are able to raise money from industrial firms in proportion to the size of their payroll and to disburse this money in relation to the amount of training done. They advise on training methods and carry out inspection. The establishment of this organization has been a major job; it still has a long way to go and a lot to learn, but I believe that it will ultimately be effective and will improve standards of craftsmanship.

That, then, is the engineering army as it exists today; research and development are the analogues of the intelligence and reconnaissance organizations, professional engineers of the officer corps, technicians of the non-commissioned officer corps, and craftsmen of the other ranks. And this engineering army is as vital to a country in time of peace as are military forces in time of war. National well-being depends on trade and, in this modern mechanical world, trade depends on engineering. But no military force, however well organized, can be successful unless its relationships with Government are satisfactory and the relationship of Government with engineering is similarly important. This relationship is controversial but I feel that I should be failing to cover my subject if I stopped short of talking about it.

It took centuries to evolve a satisfactory national organization for the conduct of

war; indeed, it is probable that in the United Kingdom a reasonable organization was first achieved during the Second World War. In that organization the main business of war was carried out under the War Cabinet by the Defence Committee (Supplies) and the Defence Committee (Operations); the Prime Minister acted as Chairman of both of these. Under the Defence Committee (Operations) and reporting directly to it was the Chiefs of Staff Committee to which the Joint Planning Staff and the Joint Intelligence Subcommittee reported. The Cabinet was directly in touch with, was advised by and promulgated its instructions through professionals who were expert in the subjects with which they dealt.

No one who believes in democracy would argue that an identical organization or identical procedure could be applied to the relationship between Government and Industry in time of peace. In major war a country has one single national objective, namely, to ensure the success of its armed forces; but surely the primary national objective in time of peace should be to ensure the success of the country's industry. It is only industry which earns money; domestic, social and foreign policy depend on money. I suggest therefore that industrial well-being should be the first object of Government.

It is probably best to leave Government to politicians, but can politicians, advised mainly by career Civil Servants (whose training is largely in making juridical decisions) and by part-time committees of industrialists and economists with no executive power, ensure the success of industry? To assume that they can do so is like assuming that Government could, in time of war, control operations through Civil Service and through committees made up of officers who came when necessary, but who were normally leading troops in the field. Might it be possible to have, in peace, a full-time committee of experienced industrialists with the same direct access to the Cabinet that the Chiefs of Staff Committee has in time of war? It may be argued that no democratic Government could direct and influence peacetime industrial policy as it does wartime military policy, but there are many sanctions that it could apply to mould industry to the national interest. It can, for instance, influence the ordering policy of Government departments and State-owned utilities and it can expose those industries where organization is considered to be unsatisfactory and which resist change to the cold winds of international competition. I know that such a suggestion is provocative, but before anyone says that it could not work in a democracy I think that he should ask himself whether any democratic Government has yet approached the problem with the conviction that the success of industry in time of peace is as important as the success of its armed forces in time of war. Perhaps the United States, which drafts distinguished industrialists into its Government as departmental heads, comes nearer to finding a solution to the problem than most democracies.

But besides learning from wartime analogies in the strategical planning of industry, I wonder whether Government might learn something about effective execution of policy by Civil Service departments from consideration of wartime experience. I worked during six years of the last war in the Ministry of Supply and feel that after the confusion which was inevitable in its formative stages had been resolved, I had never worked in a more effective organization. The staff was made up of a mixture of career Civil Servants and men seconded from industry. The managerial organization of its various sections was generally in line with what would be used in industry to deal with similar problems. In these days when many Government Departments deal with problems which are of an industrial nature might it not be wise to use similar practice in time of peace, to use industrial rather than Civil Service management structures within Government Departments for the management of affairs which are of an industrial nature, to encourage a good flow of men from industry into the Civil Service and from the Civil Service into industry? The place of the engineer in the development of a country must depend to an important extent on the part which he is able to play in helping to formulate and propagate Government policy for industry.

You have asked me to look forward, as you are trying to do, over the next ten years and to foresee the place of the engineer in the development of a country. I see the need for engineers to play a greater part in the formation and promulgation of Government policy. I see engineering becoming more complex and in many ways more specialized. Engineering is the art of producing material things which add to the amenities of life, and however complex and specialized it may become that aim must be remembered. It will only be achieved if engineers learn to understand better the importance of their relationships with the other members of the team of which they form part, the importance of this relationship with scientists, financial experts, economists and with the technicians and craftsmen. All these together form the industrial army which produces material benefits; leadership goes to whoever has best fitted himself for leadership.

But the ultimate achievement of engineering is not only a material one, for science and technology have done more in the last ten decades to raise social conditions than the humanities have done in the last ten centuries. I realize this most clearly when I was in Tasmania a few years ago. My reason for going there was to see hydro installations and industrial plants, but in my week-end I went to Port Arthur and visited the site of the old penal settlement. As I looked at the ruined "model prison" in which men used to go mad in solitary confinement, as I thought of the floggings and mass hangings, as I looked out at Boys Island to which children of twelve were sent for offences for which they would today be put on probation, I found if difficult to believe that there were still prisoners at Port Arthur during my father's lifetime. I stood in those lovely surroundings (Port Arthur is in one of the most beautiful places I have seen anywhere in the world) wondering why it was that a standard of humanity which had been normal throughout all history should have so changed within two generations. And I realize that the explanation lay not in the schools of humanity or even in the churches—their teaching has remained unchanged—it lay in the industrial plants that I was visiting on my working days. Cruelty is largely the product of harsh living conditions and it is the great contribution of science and technology that they have given gentler living conditions and created a climate of comfort in which better standards of humanity can thrive.

This is a real achievement and one of which we engineers should be proud, but in our pride we should be careful to remember that there are still many countries where the rate of industrial progress which is being achieved is too slowly introducing those material amenities which are elsewhere regarded as a right. In these days of easy communication differences in standards of living do not remain concealed. The problem is similar to that which was faced on a national scale by the great reformers who, in the second half of the nineteenth century and the early part of this century, overcame the problem of raising the standard of living of underprivileged workers. On its present international scale the problem is greater, but it is equally essential that it should be solved. In relation to the size of its industry Canada is doing more than most countries in attacking this problem and I meet Canadian engineers who are helping in the developing countries in many parts of the world. When you look forward to the future and think of the place of the engineer in the development of a country I am sure you will remember that it is not only of your own country that you should think—you must think of the world. It is we who have created this problem; engineering has made the world a small place and engineers must not shrink from the difficulties which result from their achievements.

A New Shape

LIEUT-COLONEL F. W. L. SHEPARD, MBE, RE, BSc, AMICE

INTRODUCTION

THIS article tells the story of the reconstruction of SHAPE in Belgium following the French request for the withdrawal of all NATO military headquarters. The new SHAPE became operational at Casteau, near Mons, on 31 March 1967, less than six months after work had started at the new site.

BACKGROUND

Supreme Headquarters Allied Powers Europe is the highest military headquarters of the North Atlantic Treaty Organization. It was established in 1951 at Roquencourt near Versailles under the command of General Eisenhower with responsibility for peacetime planning and wartime control of all NATO forces in Europe. By 1966 the headquarters had a staff of over 3,000, with over 5,000 dependants, but most of the buildings were still in temporary construction. Although a new permanent headquarters had been planned in 1965, this project was abandoned in view of the French political position.

On 8 March 1966 the French Government wrote to the NATO nations affected requesting withdrawal of allied troops, bases and headquarters from France, and fixed 1 April 1967 as the date by which the withdrawal should be completed.

On 6 June 1966 a meeting of the fourteen non-French NATO Ministers in Brussels decided that SHAPE should move to one of the Benelux countries. On 11 June Belgium agreed to provide a site for SHAPE, and on 21 July the Casteau area was suggested.

On 13 September NATO accepted this site for SHAPE.

PLANNING

As soon as the probable new site was known a detailed study of construction requirements began at SHAPE. This headquarters has no Chief Engineer, and the responsibility for all construction work rests with the infrastructure Branch of the Logistics Division. Ironically enough this branch was headed by a French brigadier, who was withdrawn from SHAPE with other French staff officers on 30 June 1966. From then on construction planning for the move was carried out by a small team of Engineer and Administrative officers under Colonel J. B. Newman, US Army, with the writer as his deputy.

The first step was to prepare a statement of SHAPE's requirements for usable floor space. This was simplified by the existence of the plans for rebuilding SHAPE at Roquencourt, but the latter did not include any provision for new administrative support buildings or family housing. Space allocation was based on NATO standards where these existed, otherwise on an average of national standards. Fortunately all of SHAPE's many departments agreed quickly on their needs; it was apparent to everyone that there was no time for argument.

This statement of space requirements was used as a basis for initial cost estimates and all subsequent planning. No changes were allowed once requirements had been approved, and this contributed greatly to the speed of construction.

The next step taken in SHAPE was to establish details of requirements for offices, operations rooms, stores, workshops and all other operational buildings. To do this quickly a standard *pro forma* was devised showing an outline floor plan of a typical modular prefabricated building with a central corridor.

Each SHAPE Division was required to indicate its proposed layout on this *pro*

forma within the floor space approved. Finally all Divisions were asked to produce detailed lists of special requirements for each room including power supply, telephones, built-in furniture and equipment, exceptional floor loadings etc.

From this information a comprehensive brief for the Belgian Government was prepared and handed over on 6 September 1966, one week before the formal decision to move to Casteau.

The Belgian Government immediately undertook to build all SHAPE's essential military requirements by 1 April 1967 at an estimated cost of £6 million, provided NATO funds were available by 1 October 1966.

Normally the peacetime programme for NATO construction work takes about three years from submission of the original requirements to the actual start of work. Fortunately in this case the NATO nations were prepared to waive the usual procedure and make funds available immediately, and the Belgian conditions were met.

Nevertheless it was difficult to believe that this schedule could be achieved, since most of the work would have to be done in winter months. The second and third phases including administrative and amenity buildings estimated at £10 million are scheduled for completion by October 1967, and a total of 1,600 family houses, of which 600 will be on site, are being built under separate financial arrangements.

CONTROL

Much credit is due to the Belgian Government for the whole-hearted way in which they tackled this "crash" programme. An inter-ministerial committee for SHAPE was set up under the direction of the Comte de Kerchove de Deterghem, a former Ambassador to the Congo. This committee was able to obtain the co-operation of all the Ministries and local authorities involved and to get decisions without delay.

Control of construction was vested in a team of Belgian Army Engineers headed by Lieut-Colonel Bonheure, who was able to draw on a rich fund of experience in the Belgian military construction service, which is still responsible for all Army works. Expert help and advice was also given by the Belgian Ministry of Public Works in planning, design, and site supervision.

The SHAPE team worked alongside the Belgians from the beginning of September 1966. Originally we were inappropriately accommodated in the Psychological Warfare branch of the Ministry of Defence, but later offices were generously made available by the Director of Military Construction, Major-General Tinant.

Having received details of SHAPE requirements the Belgian team at once called for bids from Architect/Engineer firms for planning, design and supervision of the work. The bids were received in forty-eight hours and within a week a consortium of leading Belgian firms had been selected. At the same time design and building tenders were invited from principal prefabricated building contractors for the first-phase buildings, which included the main headquarters, communications centre, single officers and troops quarters, messes and administrative offices.

By 1 October five main contractors had been selected and by 17 October work on site had begun.

Site control was exercised by a Belgian Engineer officer, with technical supervision provided by the Architect/Engineer Consortium and the Ministry of Public Works. The Consortium was also responsible for programming control. This was exercised by the PERT Critical Path System with the aid of two computers.

Briefly the programmers produced dated task lists in conjunction with contractors and reviewed these at weekly meetings on site. One computer was used to check tasks against restraints and to establish critical paths. The second computer produced a printed programme giving earliest possible and latest acceptable dates for each task.

In practice this elaborate system was effective in avoiding delays. All Phase I buildings were completed on or before their scheduled dates, and possible bottlenecks were generally spotted well in advance.

THE SITE

The Camp of Casteau, shown in the photograph at Figure 1, had been a military training area since 1825. It is roughly one mile square, with a narrow strip half a mile long and 100 yds wide, extending from one corner. The main road from Mons to Brussels adjoins its southern boundary. In 1966 the site contained a Reserve Battalion Barracks, a disused Ammunition Depot, and a local Aero Club. As secretary of the SHAPE Gliding Club, it was the writer's unhappy duty to break the news that the Aero Club could not remain at Casteau.

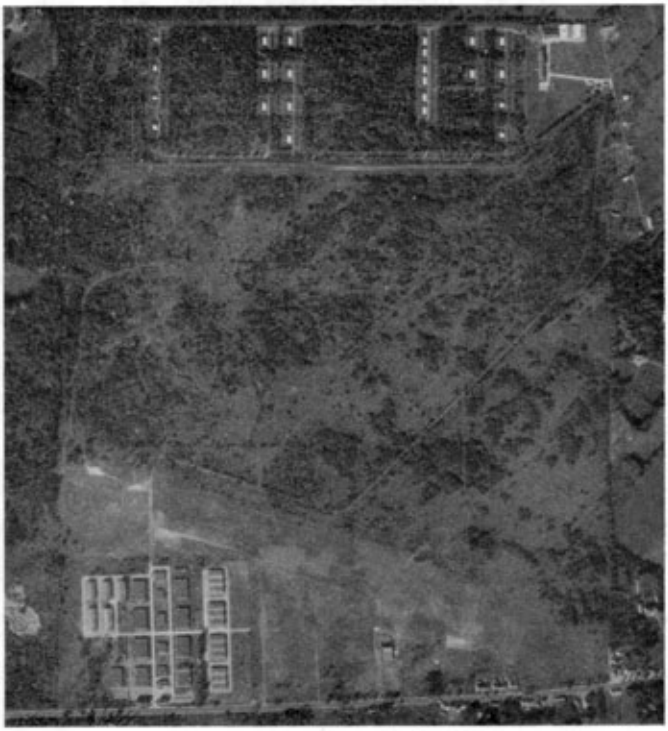


Figure 1. Casteau Camp—October 1966.

Although on relatively high ground with sandy top-soil, nearly half the available area had a water table very close to the surface owing to an impervious layer of clay of varying depth and thickness which prevented the water from escaping.

In September 1966 the cellars of existing buildings were found to be flooded to within 5 ft of ground-level.

Fortunately most of the Phase I buildings were sited on comparatively good

ground and the damp soil had produced a fine crop of trees in the areas selected for family housing.

The new SHAPE layout follows a conventional zoning plan, as can be seen from the site plan at Figure 2.

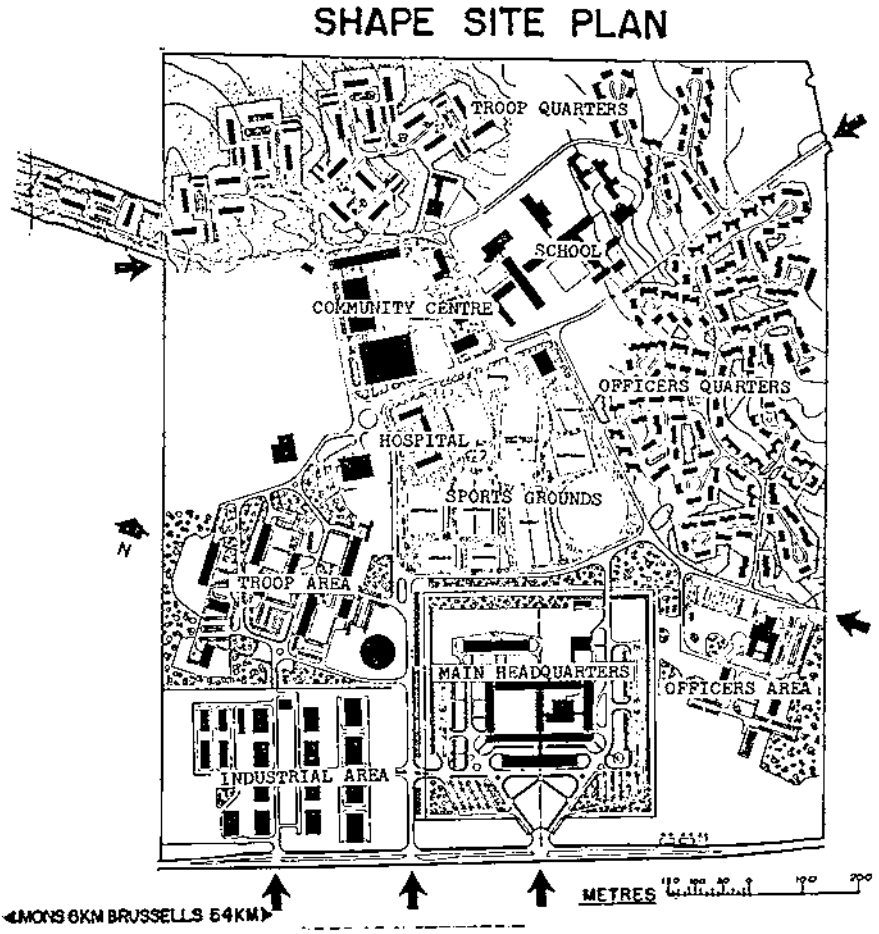


Figure 2. SHAPE Site Plan.

BUILDINGS

In initial discussions with the Belgian construction team it was assumed that simple prefabricated buildings were essential to completion within the time limit. It was also decided to limit construction to three storeys to reduce requirements for lifts, to simplify design, and to reduce foundation loads.

The SHAPE main building layout was dictated by its specialized operational needs and security requirements. Standard modular three-storey office blocks with central corridors are connected to form two hollow squares with sides 100 yds long. One square is occupied by the Operations Centre, a three-storey windowless building with full air conditioning.

In front of the main building, and connected with it by a corridor, is a two-storey block containing cafeteria, public conference room, and other support facilities. All these buildings were designed with precast concrete wall panels, although for the main building floors and columns were cast *in situ* with a labour force of up to 600 men on site.

Single officers and troops quarters were of standard precast concrete construction, but the troop messes and communications centre were built almost entirely of timber, and a subsidiary headquarters building had steel framing and cladding with a British steel troughing system for roof and floors.

In each case design was governed by the prefabrication systems available to the contractors selected and standardization was not possible.

In most cases normal strip concrete foundations were sufficient with some reinforcement of walls below plinth level, but for some buildings it was necessary to use bored piles of the Frankie type to a depth of about 20 ft. In other cases pockets of bad ground were removed and replaced with compacted quarry waste up to 10 ft thick. So far no signs of settlement have been observed.

Because of the short time available it was decided that each building should have its own heating plant. For Phase I buildings oil-fired equipment was used, but for all subsequent construction gas heating is planned to take advantage of the economies offered by projected natural gas supplies.

SERVICES

The existing services for the Camp of Casteau were sufficient only for the Reserve Battalion Barracks, so a complete new system had to be designed by the Architect/Engineer Consortium. This included a water supply of half a million gallons a day through two miles of pipe, foul and storm drainage to town systems 1½ miles from the site, electricity supply for an installed load of 15,000 kVA, and about seven miles of road.

As was to be expected, the services proved more difficult to complete on time than the buildings, and various temporary expedients were brought into use to enable SHAPE to become operational on 31 March. A mysterious failure in the water supply was traced to a rabbit caught in a pipe, and a spectacular short circuit which blacked out the town of Mons was caused by a bulldozer cutting the main 15,000-volt supply cable; the operator was unhurt. Fortunately a sewage-treatment plant did not have to be constructed, but a pumping station was necessary for part of the foul drainage systems and this had some teething troubles.

COMMUNICATIONS

SHAPE cannot function without adequate communications, and these have to be complex in the extreme. Over 2,000 pairs of cables were laid into the communications centre, which includes a large automatic telephone exchange with numerous teleprinters and other electronic equipment. To ensure that all communications were fully tested and working properly by 31 March 1967 it was necessary to complete the building by 15 December 1966, less than two months after the order to start work.

The successful completion on time of this fully air-conditioned 24,000 sq ft timber building was a remarkable achievement.

Other communication installations included a 200 ft high tower and transmitter and receivers at remote sites. An emergency power station of over 1,000 kW was provided to ensure maintenance of communications and essential operational requirements.

CONSTRUCTION

The Phase I contracts were placed formally on 1 November 1966, but most of the contractors concerned jumped the gun by up to a week to take advantage of the fine autumn weather.

Figure 3. Casteau Camp—December 1966.

During the next five months progress, as can be seen from the photograph at Figure 3, was dramatic; up to 2,000 men were employed on site working two and sometimes three shifts per day.

The winter was luckily fairly mild, but although much rain and some snow fell this was not allowed to slow down the work. Two buildings were fully enclosed in heated temporary structures, but for the others concreting continued in the open with the aid of heated water and chemically treated cement. Heating systems were put into operation at the earliest possible moment and helped to speed the completion of interior work.

Over twenty main contractors and at least 100 subcontractors were at work simultaneously; fortunately a remarkable spirit of co-operation prevailed, although the weekly progress meetings did get a bit heated at times. These were conducted in a mixture of French, English and Flemish and provided a severe test for the minute-writers.

No delays were caused by shortage of materials; regrettably the only major failure to meet delivery dates was due to a well-known English firm, and this was rectified by Belgian improvisation.

Figure 4. SHAPE Buildings—March 1967.

A New Shape 4

Work on the external services was late in starting owing to design difficulties and was hampered by the necessity of maintaining access to buildings. At one meeting the road contractor was heard to cry "Mon Scraper est immobile"; nevertheless the roads were completed on time.

CONCLUSION

The short time available for planning caused fewer mistakes than might have been expected. One positive advantage was the lack of time for major changes; also designs were necessarily the simplest possible consistent with requirements.

Prefabricated buildings are obviously best suited to rapid construction, and it would seem that much greater use could be made of timber in this respect.

External services proved to be the biggest problem, and the importance of starting these early in the building programme was very evident.

This was a fascinating project to work on. Belgian enthusiasm for hard work and ability to get things done were most impressive, and the ability of the NATO nations to co-operate in an emergency was clearly demonstrated.

ACKNOWLEDGEMENTS

The photographs are reproduced by kind permission of the Belgian Ministry of Defence, and the site plan by courtesy of the Architect/Engineer Consortium, Group Alpha—Sobema Electrobel—Gibbs and Hill.

Specialist Team RE (Construction) in Aden—1966

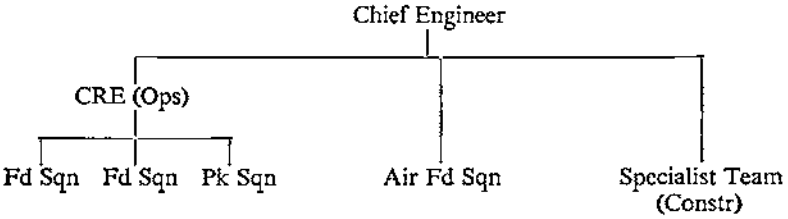
MAJOR D. I. KNIGHT, RE

ORGANIZATION

IN September 1965 I started forming up one of the first Specialist Teams (Construction), to carry out works services upcountry in Aden. MPBW civilians had withdrawn from upcountry about eighteen months earlier during the Radfan operations, and their place had been taken by a hastily formed team of a Garrison Engineer and five Clerks of Works. Although they came under the military command of the Chief Engineer, their work was planned, designed and costed by MPBW civilians who did not enter the operational area. This was unsatisfactory both for the Army and the MPBW, and so our team was formed.

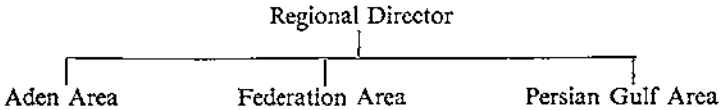
Our Specialist Team was a normal Sapper unit under command of the Chief Engineer, but financially responsible to the Regional Director of MPBW for work funded by him. We were similar to a RE Squadron in having five Officers and fifteen Senior NCOs and although our establishment had less than a dozen military Rank and File, we employed up to 500 civilians and controlled contractors with up to 600 civilians working exclusively for us.

Broadly the Sapper organization in Aden was:—



One Field Squadron worked on the Dhala roads, the second supported Army units, and the Air Field Squadron supported the RAF. Sapper units, including ours, worked on airfields and on works services in areas where MPBW were unable to provide a normal service. The Park Squadron had a Well Drilling Troop that drilled a lot of wells upcountry, and held the Command Construction Laboratory which we operated.

At first nearly all our work was funded through MPBW, who made me an Area Officer responsible for the Federation Area. I had the normal financial powers of an Area Officer, allowing me to approve works services up to £2,500, which was similar to the authority of our old CRE (Works). MPBW's organization in the Middle East was:—



We set up our headquarters in Aden in air-conditioned offices owned by MPBW, which enabled us to share their Common Services for printing, duplicating, photocopying and typing. They loaned us an Executive Officer for several months to

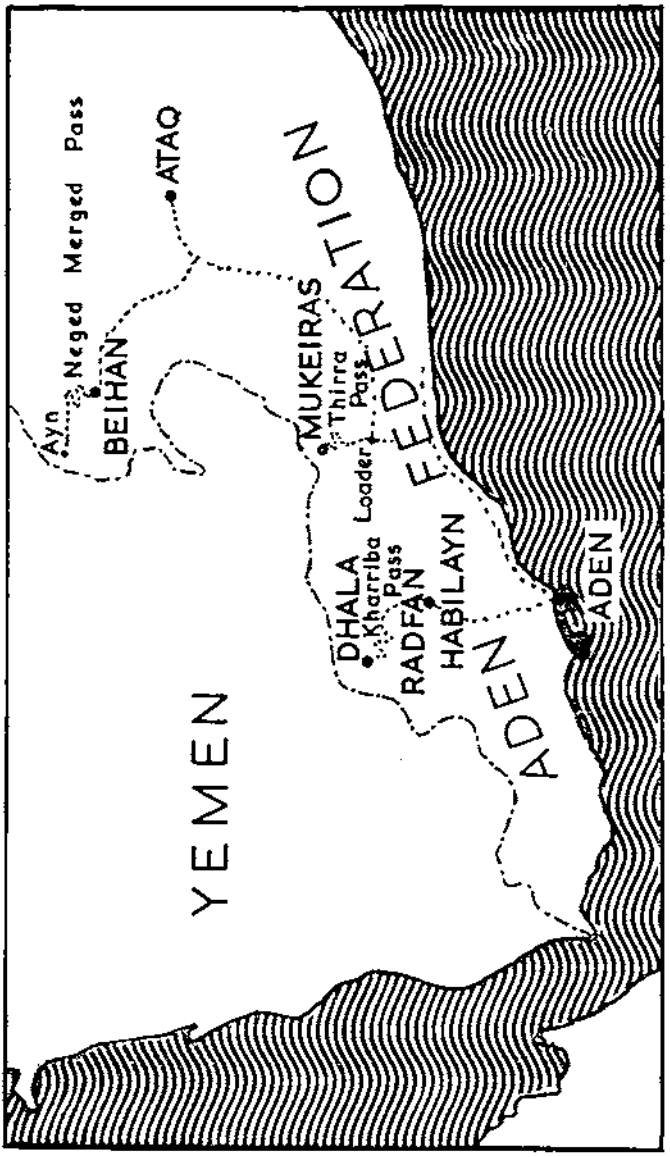
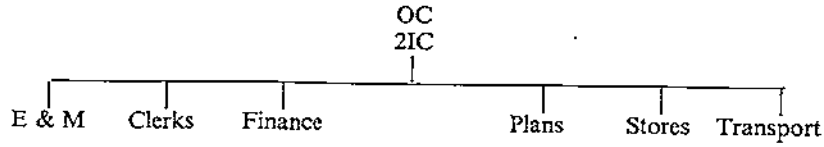

YEMEN
ADEN
FEDERATION
Ayn
Neged Merged Pass
BEIHAN
ATAQ
MUKEIRAS
Thirra Pass
Loader
DHALA
Kharriba Pass
RADFAN
HABILAYN
ADEN

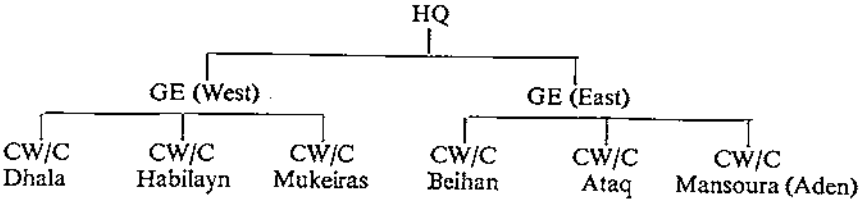
Fig. 1

train our finance section, provided us with three lady clerks, and gave us furniture, stationery and Arab labour. Our headquarters organization was:—



I split our headquarters into six sections, and included an office for the up-country Garrison Engineers to use when in Aden. The office block was in the town with no room for our stores and transport, so I installed them in Normandy Lines, where we lived.

Normandy Lines had a camp administrative staff, which allowed us to use messes and a central clothing store, and our soldiers were paid by a Survey Squadron who were also in Normandy Lines. The organization of sub-units was:—



The working Sub-Unit was represented by the Clerk of Works (Construction), who was permanently resident at his station. The Garrison Engineers were constantly on the move flying between Aden and their stations planning work, chasing progress, maintaining working standards, and controlling expenditure.

DEVELOPMENT OF THE TEAM

Our team at first merely replaced MPBW civilians in the headquarters in Aden, and took over Arab labour forces under military Clerks of Works upcountry. As our team grew we increased from four to six working sites, and the volume of work rapidly increased, particularly at Habilayn. At each station upcountry we had a Clerk of Works and a couple of Sapper tradesmen from Field Units controlling about 100 Arabs. Transport and plant were provided by MPBW, but when MPBW plant was not available we were able to borrow Sapper plant from the Chief Engineer's pool.

Before the British withdrawal from Aden was announced, most of our effort went into temporary British camps calling for electric wiring, concrete floors and timber and corrugated-iron structures with an occasional stone building. British troops lived at a higher standard than the Arabs, which put a considerable strain on our electrical and mechanical section, maintaining electrical supplies, water pumps, refrigerators and cold stores.

With the announcement of withdrawal came a decision to build permanent up-country barracks for the Arab Army, which would have taken about five years using our direct labour. To complete these barracks before the withdrawal we changed over from direct labour to contracts with a twelve-month contract for each site. We committed about £500,000 on these barracks and could have done more had the money been available. As each contract was let we reduced our labour force, taking care to reduce it gradually to avoid local unrest. We aimed at keeping a maintenance team of about a dozen men under an Arab foreman to remain at each site when the contracts were completed and our team had withdrawn.

The five upcountry stations all had something in common, though each had its own character. Mansoura was different, being an Aden suburb where we tried to get work done with entirely Sapper labour.

MUKEIRAS

Mukeiras at 7,000 ft was the highest station, and relative to Aden feels extremely cold in the winter, with occasional frosts. It has an excellent oiled airstrip that had recently been rebuilt by the Air Field Squadron, and which we maintained with Arabs, using a 1,000-gallon bitumen distributor to spray oil and an 8/10-ton roller. Aeroplanes were the main link with Aden, and were used to move troops, rations and most Service stores, though heavy items and most of our stores came by road.

On my first visit a group of people met our Beverley, including the village idiot, who carried a rifle with a barrel bent through about 30 degrees. Most Arabs up-country carry a rifle, but the local ruler had had his barrel bent for safety. He approached us and insisted on giving us money which we had difficulty refusing. On a later visit he threatened to throw a large rock at us as we drove past in our Land-Rover, which was rather alarming.

Our Clerk of Works had been in Mukeiras about eighteen months and had learnt Arabic. His men sang a chant to help them work together, and I asked what the words meant. Rather embarrassed, he explained they were singing about their great Clerk of Works who single-handed had cleared the Thirra Pass. In fact, he had taken our labour and cleared a rock fall which had closed the overland route to Aden, and for his efforts he had been awarded the C-in-C's commendation. The road up the Thirra Pass had been engineered by a South African engineer, climbing 5,000 ft in 3 miles with fifty hairpin bends, and was a most impressive sight. Most freight came from Aden to Loader in 7-ton Mercedes lorries, and was then transferred to trailers which were towed by tractors up this pass into Mukeiras.

There were two camps in Mukeiras: an Arab Army camp with a British element, and a British camp. The latter was tented with a few corrugated-iron structures. Tents had concrete floors, electric light and 4 ft high walls of sandbags or stone to protect men from bullets when in bed at night.

In the Arab camp there were two-storey stone barrack blocks: two had been built several years ago and our labour completed a third. These massive structures stood out as something quite different. Each housed a company, with its offices, stores, ablutions and flushing lavatories. These lavatories had proved a failure because the Arabs used stones where we use paper, and when ordered to use paper they merely wrapped it round their stones and the lavatories had blocked up. No amount of discipline succeeded in altering this well-established habit amongst the junior soldiers, and they had had to revert to deep trench latrines.

The barrack blocks had taken many years to build and were built by a traditional method of setting the stones in a mixture of clay and chaff which they called tean. The tean was pointed with cement to stop it being washed away.

The tradesmen in Mukeiras were better than at any other station outside Aden, but their standard was very low. The general foreman was a good organizer and a man of standing in the town, but his technical skill was limited to his experience in our camps. Masons were moderately skilled and we had carpenters of sorts, but the other tradesmen tended to be very poor, particularly electricians and fitters. We inherited two generator operators from Aden which with normal MPBW allowances earned nearly twice as much as our foreman. We managed to replace these with local men at normal rates.

There was a borehole in the camp with an electric pump and a high-level Braithwaite tank. I was told it had worked for a year, but had been out of use since the well ran dry two years ago. The camp was near the top of a hill and this had presumably been a perched water table. Water was now brought by bowser from local wells. We did some blasting at the bottom of a well to try and increase its yield, without much success. Water supply was a problem at most stations and the Chief Engineer had arranged for an AER geologist, Major F. Moseley, RE, to advise on water sources.[1] In Mukeiras he said there was no deep water, and we could only

[1] An article by Major Moseley on "Exploration for water in The Aden Protectorate" was published in the June 1966 *RE Journal*, and a follow up article appears in this issue of the Journal.

rely on shallow wells or a dam. We looked for a dam site with our Arab foreman, and I was surprised to find he owned a lot of the local farmland. In this area of bare rocks it was pleasant to see hollows with grass and pools of water, with figs, peaches and apricots growing, but we did not find a dam site near the camp.

Buying water from local well-owners was the accepted practice in Mukeiras town. It was quite a large town for the district, with mud-brick houses and a few stone buildings. An hotel had been built a few years earlier to attract wealthy tourists from Aden to the cool of the plateau, but it was so little used that one had to arrange for it to be opened. Outside the hotel was a large garden full of citrus fruits and roses, in sharp contrast to the surrounding country.

Mukerias was usually quiet and peaceful, though the camps were occasionally fired on at night. It was nearly always the British camp that was attacked and we felt safer living in the Arab camp, although we had one unpleasant incident. Our Clerk of Works was woken by an explosion and found a dissident Arab dead in the entrance to his tent, where he had killed himself trying to fix a booby trap. These incidents were very rare, but there were a number of vehicles blown up by mines, sometimes causing fatal casualties.

DHALA

Dhala is a town built in a very hilly area close to the Yemen border and backed by the Radfan tribes. The local people are tough arrogant tribesmen and quite the most difficult to employ as labour. There were British and Arab camps on separate hills and the town built on yet another hill with the Emir living at the very top in a prominent tall white palace that was regularly fired at by dissidents. There was a dusk-to-dawn curfew every night when anyone who moved was liable to be shot, the camps were blacked out, and the Royal Artillery and Infantry weapons fired their DF tasks most evenings, which made it feel a very operational place.

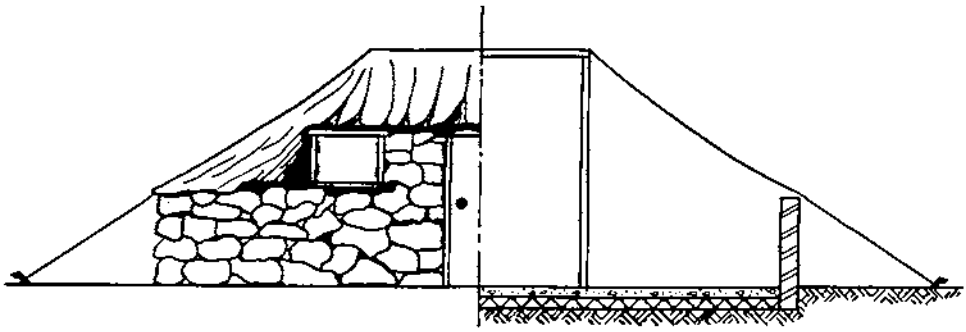
There was a rough earth airstrip about two miles from the camps on the only reasonable site amongst the hills. The strip was built up a slope towards some high mountains, making it approachable from one direction only.

We maintained the strip by raking off stones that worked their way to the surface and filling in soft spots which we compacted with a light vibrating roller that we brought in a truck from the camp about two miles away, along a very rough track. Because of the operational situation we were unable to leave any plant on the strip at night.

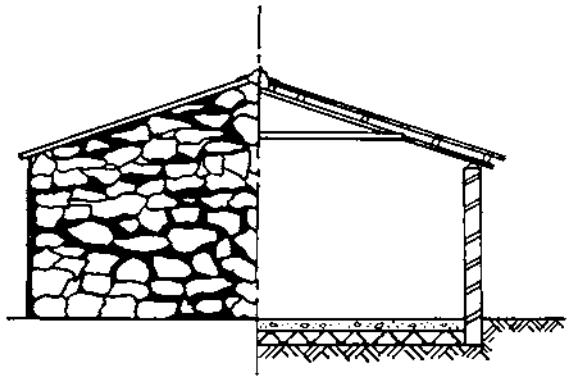
The strip was used regularly by Beverleys, Dakotas, Twin Pins and Beavers and was in use by both military and civil aircraft. It was common to see a large party of Arabs with their animal transport waiting for the civil aircraft. There was one Arab who occasionally shuffled across the airstrip with his feet chained together. We were told that he had murdered his wife, but that the Emir had spared him because he was partly insane.

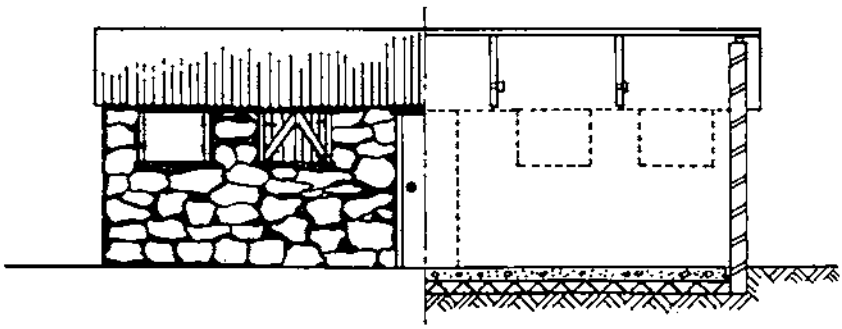
There was a general shortage of water in the Dhala area, there being little near the surface and the local shallow wells emptied in the dry season. The Sapper geologist predicted ample deep water at certain sites and when I arrived the Royal Engineers were drilling a well near the airfield track which became the main military source of water. The Well Drilling Troop later drilled a well to provide the town water supply which was most successful. The local people (and we ordinary Sappers) were always amazed at the geologist's consistent skill at finding water in this rocky desert.

The Dhala camps were tented with a few corrugated-iron huts. Some of these tents were considerably developed, with doors and windows as well as protective stone walling. The windows had no glass in them, but were just simple wooden shutters set above the 4 ft walls with the tent roof draped over them. I was particularly struck by one tent where the dry stone walling had been roughly pointed with cement mortar and the tent roof had been replaced by a light timber truss and aluminium sheeting, so that none of the original tent remained. The resulting hut



MUGS tent at Dhala





Converted MUGS hut

Fig 2.– MUGS hut converted from a tent

was extremely comfortable and we planned gradually to convert all the MUGS tents to huts in this way. At this time nothing was known of the British withdrawal and it seemed likely that these temporary camps that had lasted ten years or more might last another ten years waiting for permanent barracks. We built a prototype conversion hut (Figure 2) and based all our future tents and huts on these dimensions to allow for a logical development.

Our Dhala labour force was similar to that at Mukeiras, except that it was more difficult to control and of a lower standard. The general foreman was a lad of about 20 and was the son of a local dignitary—a wealthy scrap merchant. We had a Yemeni foreman of trades and two local foremen. The Yemeni was very inefficient and we removed him, but had difficulty getting a replacement because there was no one competent locally and the rigours of Dhala were well known in Aden. We eventually found a suitable Somali from Aden, but on the advice of the local Commander we consulted the Emir before bringing him to Dhala. The Arabs scorn the Somalis and call them "black men", so we were particularly careful to explore the position in view of the arrogant ways of the Dhala Arabs.

I went with an interpreter to see the Emir. His palace was like a fairy-tale castle, perched on the very highest point of the mountain, approached by a very steep rough track that our Land-Rover climbed with difficulty. At the top was a small courtyard full of tribesmen armed with gambias and rifles, and guarding the entrance to the palace were the colourfully dressed Emir's guards. The interpreter went ahead and when he had confirmed the Emir was ready to see us we pushed our way past the tribesmen to the palace.

The splendid white building several storeys high that looked so fine from a distance looked much cruder when seen close to. The whitewashed rendering was spattered with bullet-holes where the palace had been fired at, but the walls were thick and looked very strong. We went into the building and went upstairs, where we removed our shoes before entering the reception room. This was a fine room well carpeted, with chairs along all the walls and the Emir sitting in a large chair at the end of the room. He was dressed in spotlessly clean clothes with a tall blue turban and had a great air of dignity. I later met many other state rulers, including the Emir of Beihan, but I did not see the fine clothes or the pomp and ceremony that I always found in Dhala.

We sat down on the chairs and were given tea while we spoke to the Emir through the interpreter. He was very sensible and after we had explained the skills required by a foreman of trades he accepted that none could be found in Dhala and that we could import whoever we liked. While we were talking there was suddenly uproar outside. There was shouting and rifles being fired. The firing became intense and was very close. I was armed and so were the two chaps with me, but I seemed to be the only one at all worried. The Emir explained that these were pilgrims returning from Mecca and the rifles were being fired with joy because they had returned safely. The next moment a pilgrim burst into the room and kneeling on one knee he kissed the Emir's thigh while the Emir patted his shoulder and spoke to him. They filed in one at a time to go through this ritual and between acknowledging the pilgrims with an occasional chat to one of them he went on talking to me through the interpreter. I learnt later that it was quite usual for a ruler to interview several people at once, although they usually cleared the common people out of their courts when they had a senior visitor.

The Somali foreman of trades proved a most competent person and overnight there was a very marked improvement in our progess. Although he improved the standard and output of work, labour relations became very bad, and there developed a lot of political pressure from our labour to get him removed. He had found that a gang of thirty men led by a foreman were intentionally going slow and were causing us a lot of trouble. One day while in Aden the Arab Army Headquarters summoned me urgently to Dhala, because of labour unrest.

I flew up on a civilian Dakota and sat next to a Sudanese, who I found was headmaster of a Dhala boys' school. He said that being a foreigner had presented no problem and he thought it was only the Somalis and Indians who the locals disliked. However, they had had a problem trying to open a girls' school in the face of protests from the locals that education would only corrupt their girls. As soon as the school was opened they had burnt the headmistress.

With this story fresh in my mind I met my Clerk of Works, who said our Somali's life had been threatened and he was worried. We had started discharging the thirty troublesome men and discharging the first ten had brought matters to a head. Some minor incidents including a bomb found on the airstrip had been associated with our labour unrest and the local Commanders favoured removing the Somali and retaining our troublesome men to keep the peace. I saw the men concerned and then went to the Emir, who was again helpful. We agreed the Somali should leave and the foreman and thirty men should be discharged. The discharges were accepted without question once it was known they had the Emir's support, and I was able usefully to re-employ the Somali at a quieter station.

On another occasion we had a lorry stolen while it was out with a gang of men gathering rocks for our rock crusher. A labourer had suddenly jumped into the lorry and driven it into the Yemen. The Emir sent a message to the Yemen asking for the lorry to be returned and got a reply saying they would be delighted to return the lorry, but first they wanted the Emir's head on a plate. We never saw our lorry again. Thereafter, we always sent an Arab soldier with our vehicles when they went out of camp.

BEIHAN

Beihan is in a wide sandy wadi between hills, where the wind raises such dense dust clouds that aeroplanes were sometimes unable to land. There is a bitumen-surfaced runway which the Air Field Squadron was extending and improving, and a tented camp shared by British and Arab troops.

The Army bought water from local shallow wells which provided ample water, though they frequently silted up and had to be dug out during the dry season. We were asked to investigate an independent water supply. The Sapper geologist recommended deep boreholes, and we favoured having two close together to allow maintenance on one pump at a time. The boreholes dug by an Aden contractor would have cost about £5,000, compared with under £1,000 for a stone-lined well dug 20 ft below water-level by a local well-digger.

We discussed local labour problems with the Sherif of Beihan town, whose position was similar to a mayor. He had a businesslike office in the town where he sat at a desk, and we usually found him interviewing large numbers of tribesmen. When I visited him he always produced tea or Coca Cola, and if we had a problem to discuss he would clear the room. He spoke no English, and did not stand out as different to the other tribesmen. When I visited his home I was surprised to find his son, aged about 16, spoke fluent English, was very smartly dressed in Arab clothes, and was home on holiday from a school in Bournemouth. Visiting the Sherif's office we had kept our shoes on, but in his house we took them off. He usually took us to a small upstairs room overlooking a large water tank that was cool in the summer. There was a carpet on the floor, and we sat back on cushions arranged round the walls drinking tea.

Except for the main street, Beihan had narrow alleys where one drove with difficulty. There were half a dozen public mills for crushing palm oil, conveniently sited in the middle of the road, usually at a cross-roads to produce the maximum traffic congestion. Each mill consisted of a large wooden pestle and mortar, driven by a camel walking round the mill. A piped water supply occasionally crossed the road on the surface, and a crude system of overhead wires provided some houses with electricity. By upcountry standards it was a well-developed town.

Just outside the town the PWD were building a hospital and a school, and were finding it difficult to supervise the contractors. Their English Clerk of Works lived

in the local resthouse for a few weeks, till someone threatened him and he left. He was eventually replaced by a Greek, who lived like an Arab, and appeared to do a good job. While unsupervised the contractors did very shoddy work. One contractor levelled an area of desert with an oxen grader: two oxen towing a wooden mould board. It was a simple arrangement that worked well, and we later used it to excavate a large ammunition bunker in our camp.

Beihan had a number of outstations, including a camp at Ayn on the Yemen border. From Beihan to Ayn by helicopter took about ten minutes, but by road convoy it took four or five hours along the Negd Merged pass through the hills, and across the Sea of Sand desert. Fortunately we seldom had work at Ayn. However, a crisis led to a major move of British troops to Ayn, requiring rapid development of this simple Arab camp. I flew to Ayn with the Brigade staff, where we approved a plan prepared by my Clerk of Works and the local Commander. In about two hours on site we prepared stores lists and estimates. Next morning in Aden the Chief Engineer agreed to let me have four Sapper tradesmen and a deputy for my Clerk of Works, and the Regional Director agreed expenditure in principle. I approved £2,500 at once, which allowed Phase I of the project to start, and the balance was approved several weeks later after the usual paper battle. We immediately bought stores and had them flown in. Large tonnages of stores were flown to Ayn, mainly in Beverleys, and we soon had difficulty getting sufficient priority to compete with rations and military stores. We managed to get about 20 tons of drummed cement dropped by parachute from Argosies, which were unable to land on the Ayn strip. This strip was only a level stretch of desert which soon broke up under constant use by Beverleys, and we worked with the Air Field Squadron to improve the strip, using Arabs under Sapper supervision.

ATAQ

Ataq is set in a wide sandy plain where the ground is flat and reasonably firm. There is a good sand airstrip which we maintained and at the end of the strip is Ataq town, dominated by a very large colourfully painted house owned by a contractor. Alongside the town is the Army camp, consisting of an old stone Beau Geste fort and many rows of tents with a few corrugated-iron huts.

Arab Army units spent three months training in Ataq between tours of duty in the frontier towns. Each battalion had one British officer, who we knew as the "British Major" despite one being a RAF Squadron Leader. He was always an Arabic speaker and was responsible for all attached British troops. We found the British Majors extremely helpful, both as our regular contacts for work and to advise on local relations. Our only real problem in Ataq was the continual change of battalions and the fact that the British Major usually spent a couple of months away on leave while his battalion was away from the frontier, and he was hardly in Ataq at all. There were seldom more than a dozen British soldiers in Ataq, and they lived together in the British Senior NCO's Mess. There was a British Officers' Mess in the fort that was more picturesque than comfortable, which was opened when there were any officers in Ataq.

The Arab officers occasionally invited me to dinner in their mess, particularly at Ataq. On entering, the senior officer would introduce me to the Arab officers, who sat on chairs round the room in their Arab civilian clothes. Having shaken hands with each officer I would be offered Coca Cola or similar non-alcoholic drinks. For dinner we sat round a table laid with large plates of rice and mutton. I remember at my first dinner I helped myself to rice and my host placed a large rib of mutton on my plate. I had sat on my left hand to avoid using it until I found I was allowed to hold the bone with it, while I hacked off the meat with a communal knife. After a course of tinned fruit which we ate with a spoon, we washed our hands and had coffee in the ante-room. Conversation was always difficult, because few of them spoke any English and I never learnt more than twenty words of Arabic, but it was surprising how well we managed.

Ataq is in Wahadi State and I once met the ruler, who asked me to lunch. It was similar to dinner in the Arab mess, except that we sat on the floor. Mutton and rice eaten by hand was followed by tinned fruit, followed by a servant pouring water over our hands. However, our normal contact for labour problems was the head man of Ataq town, who had the title of Wakil Kalipha.

One of our gangers was ordered to quarry extra stone for a large mosque we were building, and when he arrogantly refused we dismissed him. We found his arrogance came from his surprising hold over our labour, who nearly all went on strike. The incident had occurred suddenly and we had dismissed him without first consulting the local ruler, which was our normal custom. Hiring and firing labour through the local ruler was a mere formality which gave him prestige and possibly some financial reward from the employee, but it also ensured his assistance when problems arose. In view of the strike I went to the Wakil Kalipha, with the British Major as our interpreter and spokesman. We sat cross-legged on the floor of his courtroom and while the tea was served we discussed everyday affairs, slowly bringing the conversation round to our labour problem. The Wakil Kalipha was apologetic, but regretted he could not help. We talked round the problem for some time and made it clear that we wanted to work closely with the Wakil Kalipha, but the best we could get was his personal guarantee that the ganger would work properly if we re-employed him. It was not a very good solution, but I accepted it. The men returned to work, but we never got the extra production from the ganger. Despite this inefficiency, it paid us to maintain a stable labour force till our mosque was built, but later when we had let a major building contract in Ataq we could afford to get rid of the ganger and the bulk of the labour.

There were occasional freak storms upcountry. One day the Wakil Kalipha visited us in our corrugated-iron office when a storm blew up. Dark clouds appeared in the distance, followed by strong whirling winds. It became very dark as dust clouds passed over the camp and it then started to hail with hailstones up to half an inch in diameter. The noise on the corrugated-iron hut was quite deafening and the Wakil Kalipha, who had never seen hail before in his life, was very frightened. It hailed for a long time, with strong winds that blew down nearly every tent in the camp and tore them to shreds. A corrugated-iron roof was torn off and blown across the camp, damaging everything in its path. Hail carpeted the area like snow and the Arab soldiers tried to make it into snowballs: few of them had seen hail before. The wind did a lot of damage. It blew down a poorly constructed old wall 8 ft high and 18 in thick, showing the importance of "through stones" to give a wall strength. The superstructure of a deep trench latrine was blown on its side, remaining intact with the floor vertical: fortunately no one was in it! We found the roof that blew off and a similar civilian roof failure nearby at Nissab resulted from the timbers lifting off the wall. This first-hand experience of wind damage influenced our design of structures for the permanent barracks that we later built by contract.

HABILAYN

The camp at Habilayn (previously known as Thumayr) was different to all the others. It was almost entirely British and as a result aimed at a much higher standard of comfort, with cold stores, numerous refrigerators and concrete floors to all tents. British troops produced a wide range of personal electric fittings, such as higher wattage bulbs, radios, electric irons and fans, which were "unauthorized appliances", but difficult to control effectively. Few troops remained for more than three months at a time and there was no permanent staff, so although the camp had existed for many years everyone regarded it as a very temporary home and it had grown haphazardly.

When I arrived I found a Sapper troop of eighteen men, including an officer and a sergeant, who employed a small team of Arabs that were mainly labourers. They were responsible for all Sapper work, which extended far beyond our team's role

of works services and airfield maintenance, and camp construction did not always have their highest priority. The troop was doing extremely well under very difficult conditions, with the Troop Officer under continuous pressure from Field Officers commanding the different independent units in and around Habilayn, who all wanted work done immediately.

The Radfan campaign was supposedly over and, although we were still on Active Service, full peacetime accounting had been introduced. Commanders who had been used to getting Sapper assistance at once found it very tiresome waiting for a works service to be planned, costed and approved before work could start. Most work was being done by Sappers, so the main effect of peacetime accounting was to delay the arrival of stores, and it was noticeable that quick improvised designs were being used to get work done quickly from whatever stores were immediately available. Where long roof timbers could not be found, short lengths had been banded together with steel tape. Electric wires all over the site were full of taped joints where they had been mended, or where new loads had been added as the camp grew.

There had been a Clerk of Works at Habilayn who obviously had not fitted in, and everyone was pleased he had gone. No doubt he had had the brunt of introducing peacetime accounting. Works services seemed to be running less smoothly at Habilayn than at the other camps and I felt a good Clerk of Works with a team of Arab tradesmen exclusively doing works services could bring some improvement. Sappers were needed elsewhere, particularly on plant tasks, and the Chief Engineer was keen to withdraw the troop from Habilayn if it could be replaced by our team supported by a few Sapper tradesmen.

The next Clerk of Works posted to us went straight to Habilayn and worked alongside the troop, giving them advice and taking responsibility for the supply of Arab labour, stores and drawings, and for financial control. Fortunately he was a first-class Clerk of Works with tact as well as professional skill, and instead of contributing the delays and red tape often associated with works services, he kept up the brisk tempo of work. Quick reliable estimates speeded up the approval of money; visits to MPBW stores in Aden improved the quality and delivery time of stores; and detailed drawings and stores lists all helped to produce good quick work. Finding Arab tradesmen, however, proved difficult.

Arabs in Habilayn were recruited by the PCLU, who employed a very colourful Arab foreman that everyone who knows Habilayn will remember. He strode about with a medal bought in the Suq on his chest, wore a hat with the cap badge of whichever major Unit happened to be in Habilayn and delighted to salute anyone who would show interest in him. He soon told us the tradesmen we wanted could not be found. We saw the Sherif of Habilayn, who insisted on showing us his jail where he had several Arabs locked up, but he was little help. We saw the Political Officer, who offered to help, but was doubtful about being able to find skilled men.

I was thinking about this problem in my quarter in Aden when a gang of MPBW Arabs came to do some repairs. The Arab in charge spoke good English and seemed very sensible and active, and after a chat I asked if he would like to be our foreman in Habilayn. It would give him temporary promotion and I found he was keen to come, and was confident he could find tradesmen to work in Habilayn at our normal rates of pay. I saw the Regional Director, who agreed at once that I could poach any of his Arabs prepared to work upcountry, and within a week Ali was our foreman in Habilayn. Through Ali we built up a team of skilled Arabs and our Clerk of Works gradually took over complete responsibility for works services. At about this time our Garrison Engineer (West) arrived and established himself in Habilayn and the Sapper troop was withdrawn.

Habilayn had suffered from the continual change of occupants who each wanted the camp laid out differently. The Brigade Staff asked us to present a proposed development plan which could be a staff controlled, and instituted regular works service meetings to agree priorities. Our Garrison Engineer consulted units and prepared a plan which led to a steady logical development. Several units came and went,

and we had a new Clerk of Works from England every six months on an emergency tour, but the Garrison Engineer was with us for two years and could see his plan completed.

Before I arrived it had been decided completely to renew the electrical distribution, because the wiring was giving trouble and in the wet season it became dangerous. The Air Field Squadron with their Electrical and Mechanical Officer and Clerk of Works (Electrical) had designed, and planned to install, the new underground system of cables with a central power station. By the time the stores arrived from England their troop to do the work had been flown to Zambia, and so we obtained extra money and arranged for a contractor to do the work under their supervision. This worked well, with close co-operation between their electrical staff and ours. The distribution problem was cured, but we still had some difficulty keeping our five generators running, largely because the dust kept damaging their sophisticated control gear.

MUKULLA

We were suddenly asked to install emergency electrical supplies very urgently at several sites in Mukulla, about 600 miles East of Aden. It is the capital of the Eastern Protectorate, which is guarded by the Hydramout Bedouin Legion, whose British Commander had just been shot dead by dissidents. We visited the sites and designed a scheme around equipment that we could buy in Aden. Obtaining electrical equipment quickly was always difficult and buying four generators around 27·5KVA each proved particularly difficult: we obtained one by getting the RAF to withdraw it at the last minute from a public auction. All our stores including the generators were flown to Riyan by the RAF and then taken twenty miles along a very rough road to Mukulla.

Fortunately at this time the Air Field Squadron was responsible for all electrical work at Habilayn while they installed the new circuits, and we could send our electrician sergeant to Mukulla. We got him a mixed team of electricians, including a Mukulla Arab, employed by the Residency ,who reported for duty drunk, with a loaded pistol, but was unable to help us because the police put him in prison! We completed the installation and arrangements were made for the MPBW staff at Riyan to keep it maintained.

MANSOURA

In the Aden suburb of Mansoura a PWD prison had been taken over to house detainees. British troops and police lived in the prison and it was decided to improve their living conditions to include air conditioning. It was thought politically undesirable to employ Arab workmen in the prison alongside Arab detainees and so the task was given to a Sapper troop under our technical control. Some £35,000 worth of work was required and it was soon clear that a troop of between ten and twenty men would take a very long time to complete it on their own.

Many large openings in the walls had to be sealed up to make the air conditioning effective and to do this quickly we had timber and glass panels prefabricated by contractors for the troop to fit. There was a shortage of Sapper electricians and carpenters, which was got over by employing Arab tradesmen under close guard.

Having been allowed to use Arabs, we were later allowed to employ Arab contractors under escort, which we found much easier to employ, because they provided all their own tools and stores and did not have difficulties getting the right tradesmen, which is a problem always met in a Field Troop. We found it a good combination having Sappers who could always be relied upon to work, and contractors who had considerably greater resources, but were subject to political pressures.

Work in the prison was not funded directly through MPBW and there was always difficulty getting money approved. A lot of time was wasted keeping elaborate accounts to satisfy different Government Departments and attending finance meetings.

FINANCE, STORES AND TRANSPORT

Having control of our headquarters in Aden made a great difference to our military team, because nearly all delays became within our control. Financial approval for work to start required six signatures from offices several miles apart around Aden, which could take weeks, if not months, to obtain. For work under £2,500 we reduced this delay to a visit to the site and some telephone calls, followed up by the paper work. Work over £2,500 was outside my control, and to avoid delays an officer had personally to visit the Command Q Staff and two MPBW offices and ask for signatures.

We had always had problems obtaining stores on site quickly. The first delay came obtaining the stores and the second came transporting them upcountry. Everything we did was costed and money had to be approved for a task before we could obtain the stores. We managed to get £5,000 to set up small stockpiles of 4 in × 2 in timber, 6 ft × 2 ft 6 in sheets of corrugated-iron and 400 lb drums of cement at each upcountry station, and we tried to base our designs on these stock sizes to allow work to start on site as soon as it was approved.

In Aden we built a Romney hut and a wired-in compound for our stores and transport. We could only afford a small stock of electrical and mechanical stores, which we held in Aden, and we held a few of our standard doors and windows which were made by Aden contractors, but our stores area was mainly used for goods and plant awaiting transport upcountry.

We were able to obtain about half our stores from MPBW and the rest had to be bought. I could buy stores locally up to £50, or with tenders up to £100, and our storemen and mechanical staff spent a lot of time visiting local suppliers, often in the dangerous market areas. Anything not available had to be ordered from England, which took three to nine months: I always tried to get schemes redesigned to avoid this delay.

Our stores were mainly moved upcountry by Arab contractors using 7-ton lorries. It was often difficult to decide whether quickly to send off a part load or to wait until we had 7 tons to move, because haulage sometimes cost more than the stores. Stores that were operationally urgent were sent by air. We had great difficulty moving stores between Habilayn and Dhala, because so many civilian lorries were blown up on mines and we relied almost entirely on military road convoys to supply Dhala.

ADEN CONTRACTS

We were allowed to use MPBW's six term contractors. Four were building contractors that prefabricated items for us, such as doors; the fifth was an electrical contractor who worked in Aden and upcountry, and the sixth was an air-conditioning contractor. As with all term contracts, work was ordered, measured and paid for at fixed rates. To avoid misunderstandings and delays I liked our Clerks of Works to measure their own work which the MPBW quantity surveyors accepted.

We also used lump-sum contracts. Provided we agreed the price in advance with the contractor, I could let contracts up to £100, but over this limit we had to obtain tenders and have a formal contract arranged by MPBW's Regional Headquarters.

UPCOUNTRY CONTRACTS

When the British withdrawal was announced we were asked to build permanent Arab Army barracks upcountry. We had made site plans of all the camps and prepared development drawings by holding meetings at each station with the Arab Army staff. We were limited by time and money and had to adopt a quick inexpensive type of construction. Our team could only complete the work in time by changing from direct labour, where a Clerk of Works employed about 100 Arabs doing £2,000 worth of work a month, to contracts where he supervised over £8,000 a month.

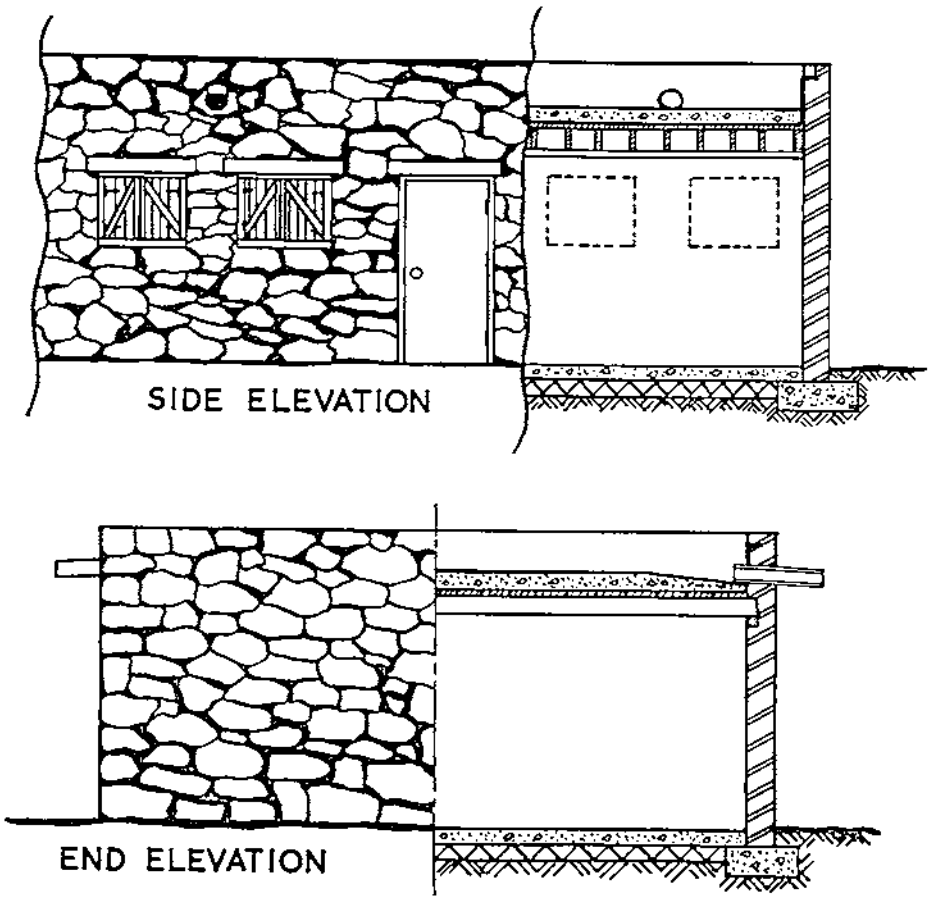


Fig. 3 – Mukeiras hut

The only existing drawings were for the Mukeiras barrack blocks and a proposed mosque. We had modified the mosque drawings and built one at Ataq with direct labour and accepted it as a standard for all the stations. At Mukeiras we planned to build a fourth barrack block and aimed to make our structures blend with the existing blocks. Otherwise our buildings were all based on two huts, built of stone or concrete blocks. One was the FRA hut developed from our conversion from the MUGS tent with a standard 64 ft long barrack room and other lengths for messes, offices and stores. The second was the Mukeiras Hut (Figure 3) based on traditional local construction at Mukeiras, in which closely spaced timber joists and boarding supported a layer of concrete designed to give overhead protection to buildings like hospitals, guard rooms and operations rooms. We decided against reinforced concrete roofs, because it was difficult to maintain consistent high standards with the poor aggregates, primitive labour and operational conditions that existed up-country.

Approximate costs of our different types of hutting, compared with standard hutted accommodation being built in Aden, were:—

MUGS Hut by Direct Labour	£	£ *per FS*
Concrete base to tent	75	
4 ft high walls	125	
Electric lighting	50	
Raise walls to 6 ft 6 in with gables, windows and door	125	
Timber and aluminium roof	75	
Total	450	0.93
FRA Hut by Contract		
This was similar to the MUGS hut, but had a higher standard of finish. Average cost was		1.42
Mukeiras Hut by Contract		
This was similar, but had a timber and concrete roof for protection. Average cost was		2.19
Air-Conditioned Twynham Hut by MPBW Contract		
This was standard British troop accommodation in Aden, roughly half the cost being air conditioning. Approximate cost was		5.47

We were fortunate in having an extremely competent Clerk of Works with quantity surveying experience, who drafted all our contracts. We kept them as simple as possible, consisting of:—

1. Detailed drawings giving as much information as possible.
2. PWD General Specification, with an amendment to cover the standards we required.
3. Particular Specification for each station specifying conditions peculiar to that station.
4. Bills of Quantities which were mainly lump sum items such as "Officers Mess as detailed on drawings . . .", though we did include detailed items for external services which were all measured on site.
5. PWD Schedule of Rates which gave prices for most common engineering works such as, "4 inch thick grade B concrete—28/- Yard Super".

The contractor priced items in the Bills of Quantities and quoted a percentage addition (or reduction) on the Schedule for carrying out any variations from the contract that we ordered. MPBW were not in any way concerned with these contracts, which we arranged entirely ourselves and had the contractors paid monthly through the Arab Army Paymaster.

With work in Aden declining as a result of the withdrawal, we found up to a dozen reputable contractors interested in our contracts, which were worth around

£100,000 each. Having sent out the contract documents, we asked the contractors to meet us on site, where we showed them round and introduced them to the local rulers. We allowed them a month to price their tenders, and a further month to get organized on site before starting each twelve-month contract.

Despite borrowing draughtsmen, our three-man Planning Section was kept extremely busy preparing hundreds of drawings and the enormous weight of paper that makes up even simple contract documents, and worked through many evenings and week-ends getting contracts out on time.

At monthly intervals each contract was completed and let at Beihan, Mukeiras and Ataq, but at Dhala we met problems. The Emir had been prejudiced against contractors by a PWD contractor who imported a lot of outside labour. We arranged for the Emir to see our contractors but when we brought them to his palace we were told he was too busy to see us. I managed to see the Emir's younger brother, who eventually agreed to see the contractors. The Emir was in the next room and the brother had to consult him on each of the contractors' queries, which was rather frustrating. After about an hour the Emir came in and spent half an hour explaining to the contractors how busy he was and apologizing for being unable to see them. Our contractors had been told of special taxes and labour regulations that the Emir was going to enforce on them. The contractors stayed at the resthouse below the palace, and that night they were alarmed by a heavy "dissident" attack on the palace. Despite all the difficulties the contractors sent in tenders with prices which compared well with our own work by direct labour.

DEPARTURE

When I left Aden the Arab Army were trying to get money for the Dhala contract and our fifth contract for Habilayn was out to tender. Both have since been let. Contracts at Beihan, Mukeiras and Ataq were generally running well, with a lot of buildings at eaves level waiting for aluminium roof sheeting to arrive from England. At these stations we had started reducing our direct labour to the final maintenance gangs. As contract work replaced direct labour, our stores section became less busy and were preparing to take over works accounting from our finance clerks, who were all British wives due for repatriation.

When I took my relief to show him Dhala we met the usual frontier atmosphere with the guns fired at dusk, but it was Ramadan and more tense than usual. One Arab in the camp had just shot another dead because they could not agree how strictly the fast should be observed. At the military well a group of Arabs were watering their camels about ten yards from us, when one fired his rifle for amusement. It was an exciting introduction to Aden!

I shall always have vivid memories of upcountry Aden, and despite all the difficulties our whole team got great satisfaction from doing useful work and helping to lay permanent foundations for the Arab Army.

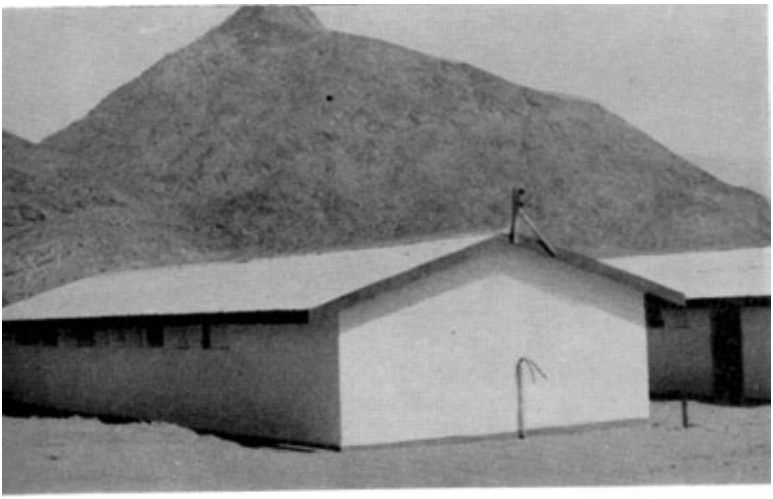


Photo 1. FRA hut at Beihan

Photo 2. FRA hut inside

Specialist Team RE Construction In Aden-1966 1 & 2

Photo 3. Mukeiras hut

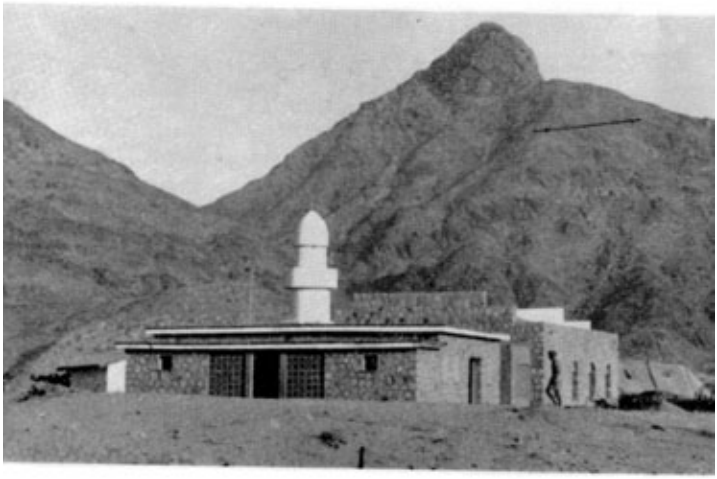


Photo 4. Mosque at Beihan

Specialist Team RE Construction In Aden-1966 3 & 4

Well Drilling in the Federation of South Arabia

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INTRODUCTION

In the June 1966 issue of the *RE Journal* appeared an article by Major F. Moseley, of the AER Pool of Geologists, giving the results of his geological surveys carried out in the Federation of South Arabia. The object of these surveys was to indicate possible sites for tube wells to improve the water supply of the area.

The Well Drilling Troop of 63 (MELF) Park Squadron have now been operating in the Federation for the past two years and it is possible to compare the results of their drilling with the forecasts of Major Moseley's surveys. In April 1967 he was also able to pay a further visit to the Federation and has recommended a revision of part of his earlier report.

This article has, therefore been written to record the practical experience of drilling in South Arabia.

GENERAL

During the past two years drilling has been limited to two areas Habilayn, previously known as Thumair, and Dhala. A general map of the area is at Figure 1. In this period four wells have been sunk and a fifth is now in progress. To experienced well-drillers this may seem slow progress indeed. It is, therefore, important to note that the Well Drilling Troop was formed in early 1965 to replace 521 Specialist Team (Well Drilling) which had then been operating in the Federation for nine months. There was very little practical experience in the newly formed troop and many lessons had to be learnt the hard way. As experience was gained, so the rate of drilling improved, as is shown in the following table, which lists the wells in the order in which they were drilled.

Well No	Depth	No of drilling days	Feet per drilling day
9	385	80	4·8
10	240	43	5·6
11	425	77	5·5
13	250	44	5·7
12	266	38	7·0

(Depth of No 12 Well is as drilled at time of writing this article)

HABILAYN (THUMAIR)

This village is situated in the Wadi Rabwa, very close to a major fault, running roughly north and south. This fault acts as the dividing line between two distinctly separate geological formations. East of the fault the rock succession is predominantly clay, sandstone and volcanic ash, whilst to the west lies volcanic rock with lavas, ashes and thin bands of sediment. Figure 2, which is taken from Major Moseley's original survey, indicates the general layout of the area and shows the location of Habilayn Camp relative to Thumair village. Two wells have been drilled in the Area, No 10 adjacent to the road and just west of the village of Al Hamra and No 13 which is on the exact site recommended by Major Moseley—B1.

Borehole No 10. This well was planned to provide a supply of water for the construction of the Dhala road as it approached Habilayn, to save the bowsering of

water from Al Milah, some six miles south, or using water from Habilayn, where the camp resources were already strained to the limit. For various reasons, delays in drilling were encountered and the well was not completed in time to serve its original purpose. It did, however, throw some light on the possibility of obtaining water from the area west of Thumair. The actual siting of the well was determined more by the practical requirements of ease of access and bowsering time than by the need to obtain large quantities of water and it was, therefore, sited as close to the road as possible. But for these considerations, site B3 would have been the more appropriate location. The site itself was on the left bank of the small Wadi which joins the Rabwa at B3, and was quite close to an existing open well which served the village of Al Hamra and which contained water to a depth varying from 4 to 6 ft. The intention was to drill to a depth of 250 to 300 ft, at which level it was hoped that a reasonable source of water would be tapped. This reasoning was based on the yield already being obtained from a very good well at Al Milah, some six miles south. A more detailed examination of the inclination of the solid rocks in the Al Milah area would have shown that those in the borehole area reached the surface only a few hundred yards north of the Al Milah wadi. The underground water flow at Al Milah was, therefore, in no way connected with that on the site of borehole No 10. The well was drilled at a nominal 8 in bore and the strata log (Figure 3) confirms Major Moseley's predictions of that likely to be encountered. It will be noted from the log that at 240 ft very soft clay was found. Attempts to pierce this resulted in the drilling tools sticking and their eventual abandonment. It is thought that if this clay had been penetrated, a water supply of considerable proportions would have been obtained. The well was eventually terminated at 196 ft 4 in, lined with 6 in diameter casing, and a pump of 689 gph capacity at 150 ft head was installed. A provisional test, prior to the eventual total abandonment of the well, provided a continuous output at 500 gph for a maximum drawdown of 2 ft. This indicated that a reasonable water supply existed above the clay level. The testing occurred during the season in which rains occur and it was noted that when the borehole was pumped the village well adjacent to it dried out fairly quickly. Because this borehole was located in territory the ownership of which had been disputed by three tribes for many years, it was not developed for civilian use.

Borehole No 13. This well was drilled to improve the existing water supplies to Habilayn Camp by some 10,000–12,000 gallons per day. It was so important to find a really adequate source of water that it was decided to locate this well on the very site recommended by Major Moseley (B1 in Figure 2), even though it was outside the Garrison perimeter and across a wadi. To protect the rig an infantry platoon was established in sandbagged positions and lived on site until the well was completed.

The site itself was on the bank of the Wadi, some 8 ft above the Wadi bed. The well was drilled to a depth of 250 ft, at which level the strata log indicated that a possible aquifer had been penetrated. It is worthy of note that several times during drilling a high rate of penetration was achieved. In some instances the tool dropped 2-3 ft at a time, suggesting that the borehole was being drilled through weak strata, which could be expected along a fault plane. Testing of the well confirmed this fact, when a definite water inflow was established at a depth of 172 ft. The strata log (Figure 4) indicated very hard black rock at this level. The calculated yield of this well was 1,020 gph, and a pump of 943 gph capacity was installed and has now been in constant use for some months. Daily, 12,000 gallons are being taken from this well, indicating that the make-up rate is consistent. The quality of the water has not been good. It contains several impurities which can only come from surface sources. This contaminated water must enter the aquifer from the base of the gravels filling the wadi and then flow down the dip of the aquifer or along the possible fault plane. Purification by chlorination is being carried out and the water requirements of Habilayn garrison have been met.

An interesting problem arose in developing this well. Although it had been essential to provide a guard to protect the rig while drilling was in progress, the

Defence Commander Habilayn decided that he could not accept a guard stationed permanently so far outside the garrison perimeter. Engineers were, therefore, faced with the problem of so protecting the well-head and supply pipe that any dissident gang trying to disrupt the water supply would be faced with too difficult a task to accomplish in one night without attracting the attention of the picquet position on the garrison perimeter. To this end the generator for the pump was placed at the water point inside the garrison perimeter. The electric cable from the generator to the well was placed in condemned pitch-fibre pipe which, with the water-supply pipe, were buried 2 ft deep from the water point to the wadi bank. Where the buried pipes crossed the wadi they were buried 6 ft deep and wired to 6 ft angle-iron pickets driven securely into the wadi bed. At the well-head, a masonry box of such a size as to enable a man to work inside it, was built to enclose the well-head and switchgear. Double walls were built so that an explosive charge placed against the outer wall would have little chance of damaging the well-head whilst at the same time alerting picquet positions. The box was capped with a reinforced concrete slab in which a square hole was left over the well-head to enable the pump to be removed if necessary. This hole was closed with a steel plate fitted with bolts on the underside. Access to the bolts was through a small hinged flap in the plate secured with a mortice lock. The recess in the concrete roof in which the steel trapdoor sat was filled with a concrete slab fitted with two lifting lugs. The weight of the slab was approximately 300 lb. The complete well-head chamber was then covered with 18 in of soil. It was considered that any dissident who was then able to disrupt the water supply in the course of one night without attracting the attention of the garrison picquets was worthy of his salt! A diagram of the well-head building is at Figure 5.

DHALA

The town of Dhala is situated on a plateau some 1,750 m above sea-level. This plateau consists predominantly of a large wadi running generally north to south, bounded on the north by hills gradually rising to the high mountainous land forming the Yemen Border, to the west by the mountainous Jebel Jihaf and to the east and south by hills which drop down several thousand feet to the foothills bordering the main wadis of the Taym and Rabwa. The area is generally volcanic in origin, the flat cultivated area of this plateau being formed from alluvial-filled wadi systems. The town of Dhala itself is situated, traditionally, on high ground which forms part of a ridge running roughly NW to SE and which divides the plateau into two distinct parts. The whole area is further subdivided by dikes generally trending west to east and acting as important obstructions to any flow of underground water. The area is illustrated in Figure 6. The drilling of wells in this area was dictated by two entirely separate requirements, namely to provide a supply of water for the FRA and British military camps in the area, and to locate and develop a supply of water for the town of Dhala.

To obtain these supplies two deep wells were drilled, the first (No 9) just north of the dyke known as Commando Ridge and at the mouth of the re-entrant adjacent to the road. The second (No 11) was sited at the location B12, recommended by Major Moseley, approximately ¾ mile south of the Dhala town ridge. The two wells are separated by the watershed formed by the high ground upon which Dhala stands.

Borehole No 9. As the strata log at Figure 7 shows, this well was drilled through rock of varying hardness to a depth of approximately 320 ft, at which level a band of soft clay was encountered. At this time the standing water-level was in the region of 160 ft, and a test conducted indicated very low water yield. After consulting Major Moseley, drilling was continued through the clay, and as it was pierced the water-level rose rapidly from 160 to 50 ft, indicating that the water source tapped was subartesian by nature.

Below the clay the formation consisted of soft fragmented rock, interspersed with clay and containing a high percentage of sand. Drilling was continued to a

depth of 385 ft, at which depth the well was cased and test pumped. For various reasons, the pump could not be installed deeper than 325 ft. However, the results of the tests showed that a water supply of very generous proportions had been obtained. This well has now been in use for some eighteen months. Due to the lower 60 ft being uncased, the clay strata has gradually fallen in and blocked off the lower part of the well. As a result the output has dropped considerably, confirming the fact that no worthwhile water supply is obtainable above the 340 ft level in this area.

Boreholes No 11 and 12. No 11 was the first of the only two wells yet drilled exactly on sites recommended by Major Moseley, namely at the location B12 on Figure 6. (The other was No 13 already mentioned.) Up to this time all previous wells had been roughly located according to the recommendation of the report, their exact locations being determined by such factors as accessibility and security from the military point of view and the requirements to disturb as little cultivated agricultural land as possible. It will be noted from Figure 6 that the location B12 lies immediately up wadi from a dyke trending east-west, and is also at the junction of the Y formed by the break in the Dhala ridge to the NE, the large re-entrant in the Jebel Jihaf to the NW, and the gorge to the south, illustrated by the route the road follows. In this connexion it is important to note that to the NW up the re-entrant water may be found on the surface, and to the south, a spring rises and flows down the gorge, at a point where the ground falls sharply away. According to local information both of these water sources are permanent, although quantity and flow vary with the seasons. Major Moseley's report recommended that the principal water supplies in the area would be contained in the agglomerate and ash formations, the depth of which could be calculated from the outcrop position and the inclination of the strata. The nearest outcrop of agglomerates to B12 occurs approximately 1,000 ft from the site and inclines at a general angle of 20 degrees. Calculations showed that a well sunk at B12 could expect to penetrate these agglomerates at a depth of 370 ft, this figure, of course, being approximate only.

It was decided to commence drilling a 10 in diameter borehole at this location and the target depth was set as 400 ft. As the strata log (Figure 8) shows, one reasonable aquifer was penetrated at a depth of 224 ft and another possible one at 302 ft. However, the principal aquifer configuration did not appear until 390 ft, when soft rock followed by clay followed by soft cavernous rock extending to a depth of 424 ft was penetrated. This was followed by several feet of very hard rock, and as this approximated to the calculated position of the agglomerates, the well was terminated and cased to a depth of 425 ft 8 in. Test pumping was carried out over a three-day period and resulted in a yield of 4,000 gph—the maximum output of the pump. The water was very clear and of good quality. The supply from the lower strata appeared to be subartesian. The aquifer at 224 ft slowed down the drawdown rate considerably, to the extent that in nine hours' continuous pumping the well yielded 36,270 gallons for a drawdown of 150 ft, the first 80 ft of which occurred in the first 15 minutes of pumping. In all, the well yielded 71,332 gallons for a total pumping time of 17¾ hours over three days.

It is intended to pipe water from this well to a Braithwaite tank built on a high point on the ridge on which Dhala is situated. From this tank gravity flow will take water to standpipes in the town and to the new hospital and school—Dhala's first piped water supply.

No 12 Borehole is a reserve well for the town supply and is being drilled 25 ft south of No 11.

CONCLUSIONS

Following the drilling at Habilayn and Dhala, important geological considerations arise which are applicable to many thousands of square miles of the volcanic terrain of this area. After a further survey in April 1967 and from studying the strata log, Major Moseley has produced further notes on the terrain of this area which are contained in an appendix to this article.

Apart from this, the success of the well-drilling programme has shown the value of the work of the AER Pool of Geologists and of Major Moseley in particular, brief though their visits to a particular area may be. Without Major Moseley's reports, a lot of water in South Arabia would have remained still undiscovered.

POSTSCRIPT

At 1330 hrs on 14 March 1967 the lunchtime peace of Habilayn was shattered by the roar of an explosion. Defence picquet positions immediately located the explosion as occurring on No 13 well. With some trepidation, those concerned with the garrison water supply made their way to the well to examine the damage.

From a quick look, it was learnt that during the previous night, which had been moonless and very dark, a band of dissidents had dug through the earth cover to the concrete slab, removed this, even though it weighed some 300 lb, and had then found themselves confronted with the steel trap door. Unable to open it, they had placed their explosive charge—some 10 to 12 lb—on the door and after setting the delay mechanism, had back filled the hole.

The force of the explosion had buckled the trap door and cracked some of the masonary, but no more. The well-head and switchgear were untouched and water was still being pumped. At the time of going to print we are now repairing the well-head chamber and hope to make it even more "dissident-proof"—and as an immediate precaution, we have arranged for machine guns, on fixed lines, to fire at the well-head at irregular intervals during the night.

APPENDIX

Geological Considerations arising from the Well-drilling Programme

MAJOR F. MOSELEY, MA, BSc, PhD, FGS

The completion of the boreholes described now gives a more reliable and empirical guide to water potential over a wide area. All these wells have been drilled within the outcrop of the Mesozoic volcanic rocks which cover many thousands of square miles within the Aden Protectorate and Yemen, extending from Habilayn, west almost to the Red Sea, and north into northern Yemen. The climate of this region, with a moderate rainfall or alternatively receiving considerable run-off from higher rainfall areas, has some uniformity, as has the terrain of craggy mountains and sharp wadis. The water régime can, therefore, be expected to be of similar pattern over the whole region, but very different, shall we say, from areas of basement rocks to the east. It is gratifying to find that water supplies are better than was at one time suspected and, although the basaltic lavas are impermeable and poor water-bearing rocks, there are sandy ashes and agglomerates of variable thickness which give reasonable supplies. The conclusions may be summarized as follows:—

(1) Water is often derived from relatively thin ash beds and it follows that the deeper the borehole the greater is the number of these beds likely to be encountered and therefore the greater the supply. In many areas it will be possible to meet target yields by continuing to drill until the supply meets the requirements.

(2) The outcrop position and inclination (dip) of the aquifer permits estimation of the depth in particular boreholes.

(3) Where the aquifer outcrops at a higher level than the borehole site sub-artesian or even artesian supplies are possible.

(4) Positions of dykes assist in locating favourable borehole points and where possible the sites should be near to important wadis.

(5) The importance of *steroscopic study of aerial photographs* cannot be over-estimated, and should be a preliminary to all ground surveys. Indeed, with the survey experience gained, and well-drilling data now available, it has become possible to make water-supply assessments from aerial photographs alone, although a short "follow up" ground survey is naturally desirable. As an example, the 1967 survey of Musaymir started with examination of aerial photographs in March. A provisional water-supply assessment was made and it is interesting to reflect that the ground survey in April did not in any way modify the initial conclusions. Confirmation from wells drilled is awaited with interest.

THE SPECIAL CASE OF HABILAYN

This is a complex region geologically which deserves further consideration. The hope was that well 13 would strike a major fault and sandstone sequence, and that this combination would result in a large water supply. However, Figure 4 shows that the borehole is entirely within the volcanic sequence and the fracture bringing in the water is probably a small fault subsidiary to the main one, which must be a farther east. In order to clarify the situation further ground survey was conducted in April 1967 and additions made to the earlier geological map. These have been incorporated in a revised map at Figure 9 and the general conclusions now are:-

(1) The present well (13) has supplies typical of the volcanic province.

(2) If the ideal site astride the main fault and into the sandstones could be located (east of 13), output may rise by a factor of ten.

(3) Wells at B4, B5 and B6 would certainly penetrate the sandstones, which have been examined in near-by outcrops, and would give good supplies.

(4) Unfortunately wells located as suggested in sub-paragraphs (2) and (3) above would be too far from the camp for use as camp supply; but if a civilian supply was contemplated there should be water available here for irrigation.

Note: The remarks on Figure 9 regarding the Main Fault should read "Main Fault must pass East of B1, otherwise sandstones would have been found in the Borehole."

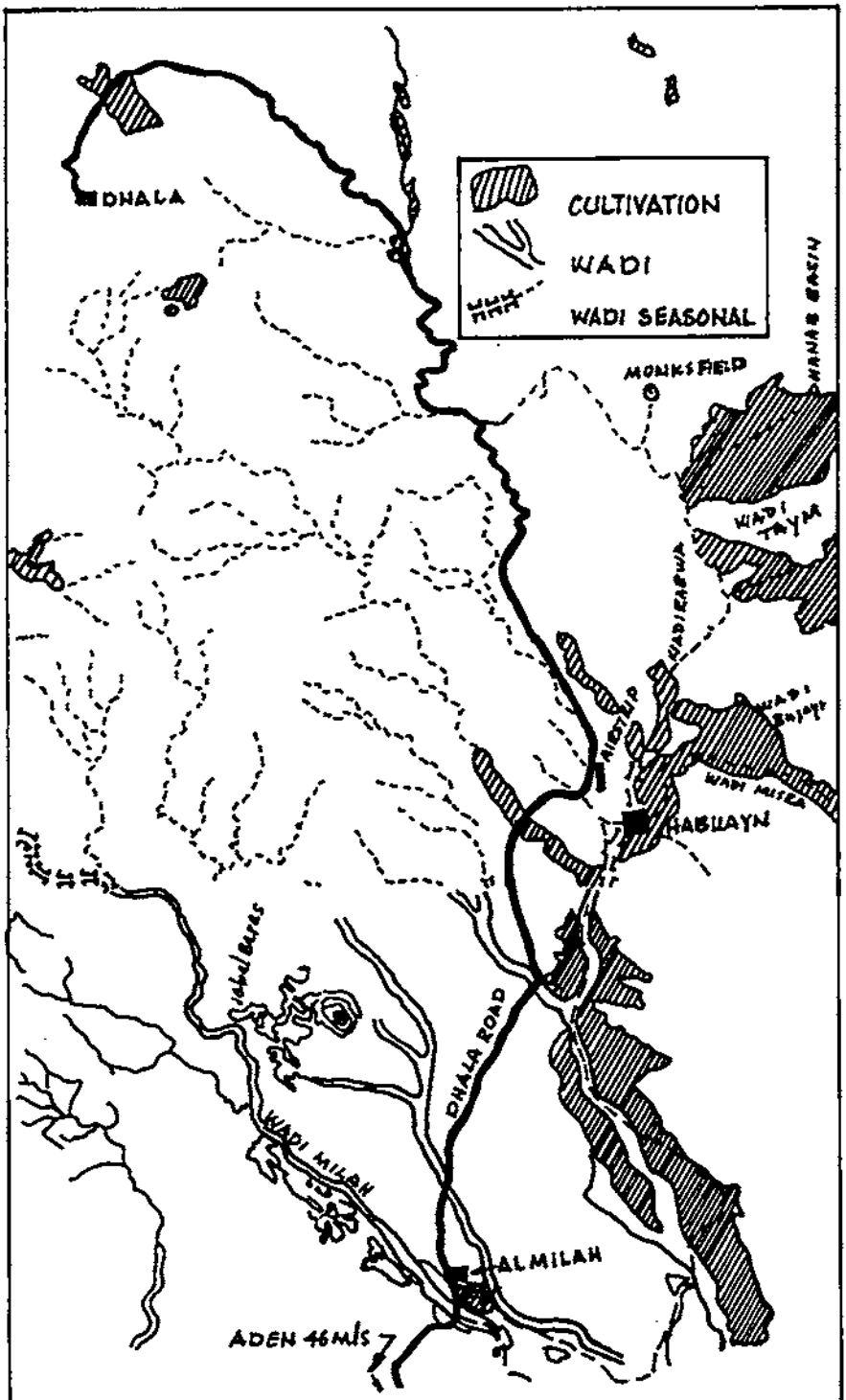

FIG I. GENERAL MAP OF HABILAYN & DHALA AREA

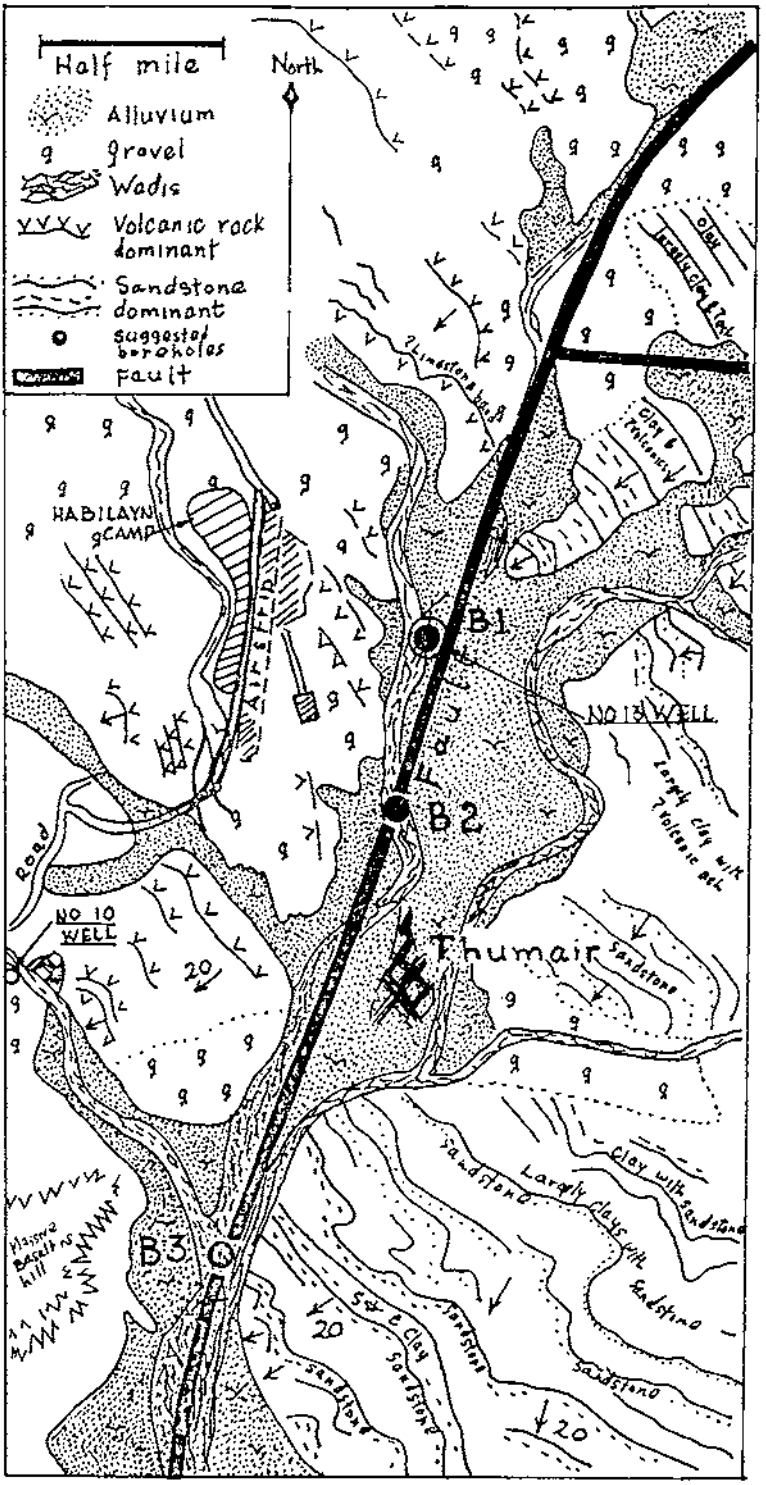

FIGURE 2: - GEOLOGICAL MAP OF THUMAIR

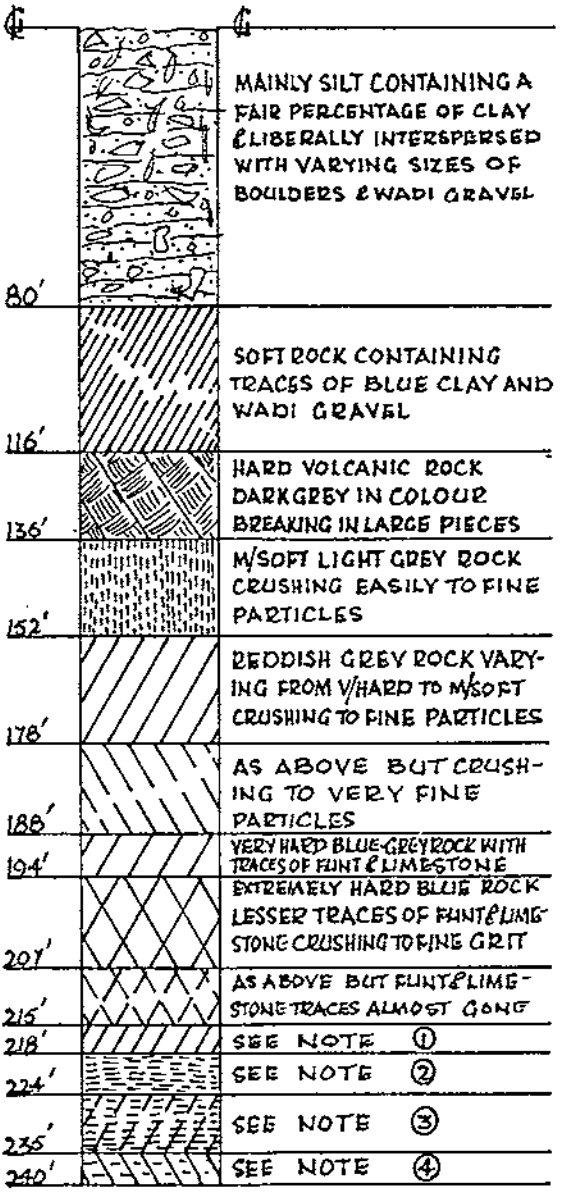

FIG 3: STRATA LOG - NO 10 BOREHOLE

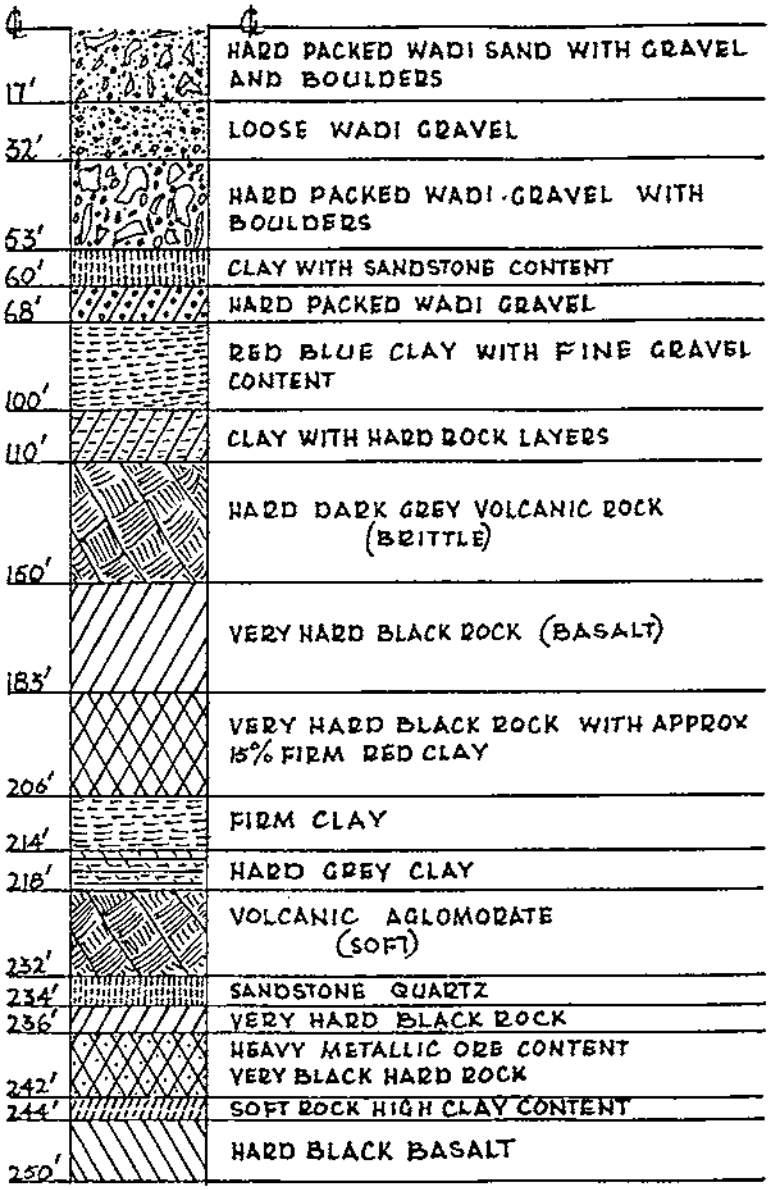

FIG 4: STRATA LOG - NO 13 BOREHOLE

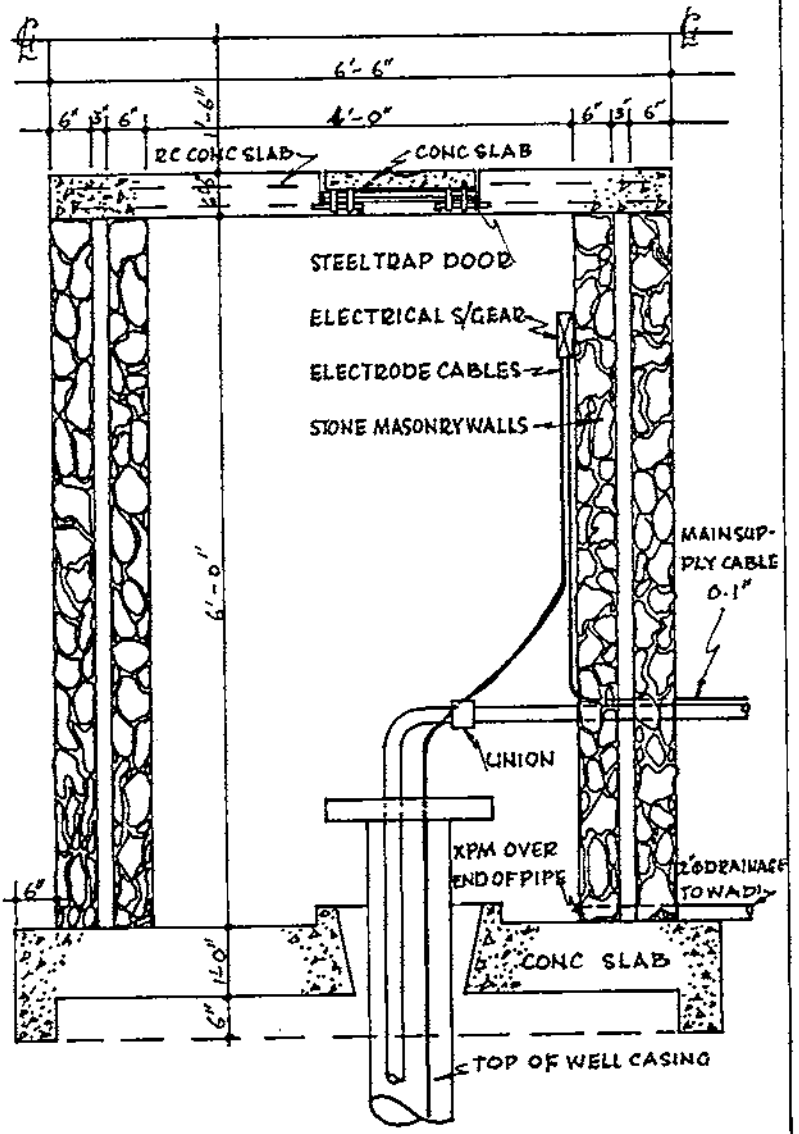

FIG 5: ANTI-DISSIDENT WELL HEAD CHAMBER ON NO 13 WELL

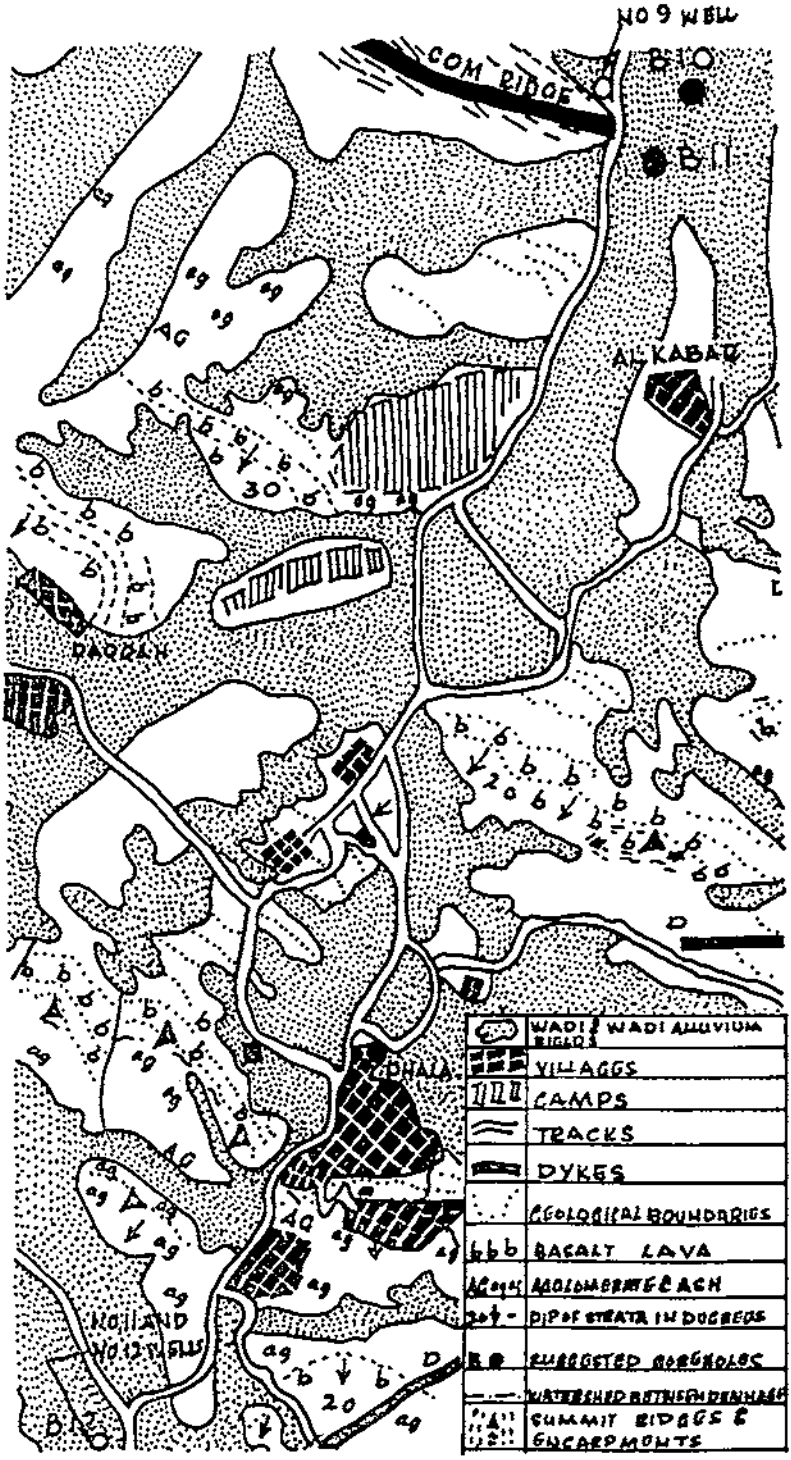

FIG 6: - GEOLOGICAL MAP OF DHALA

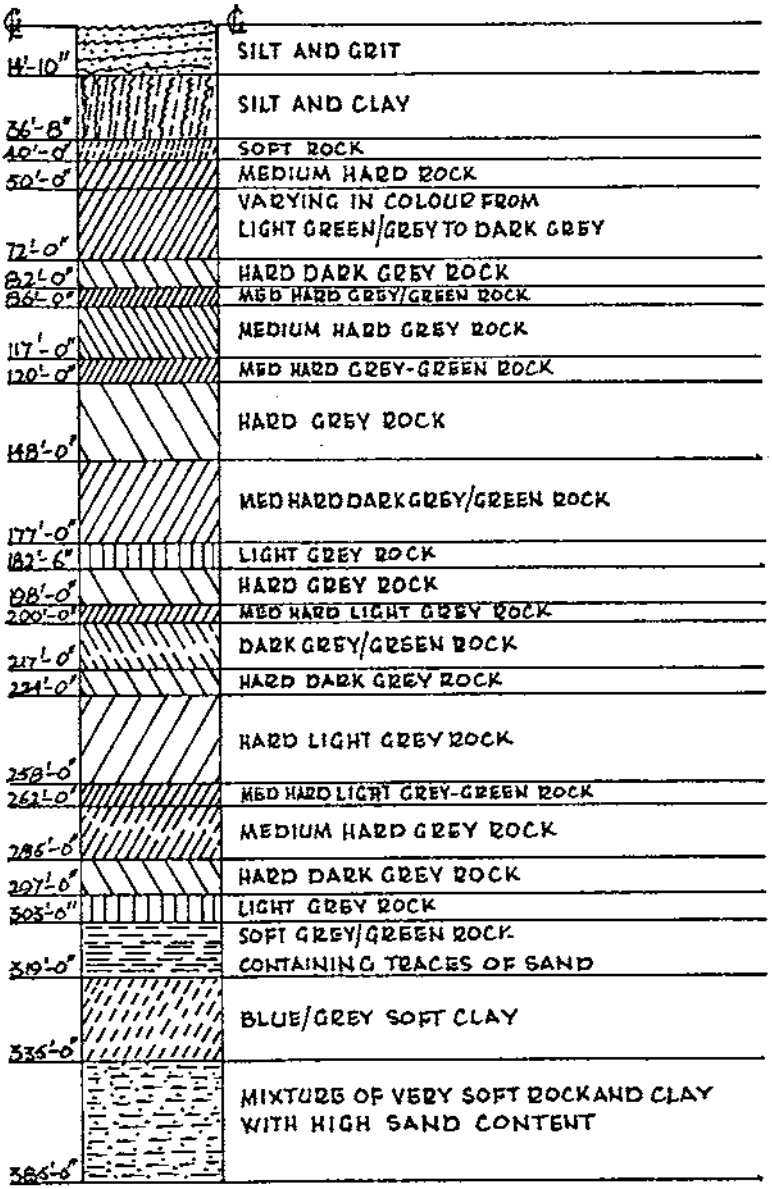

FIG 7: STRATA LOG - NO 9 BOREHOLE

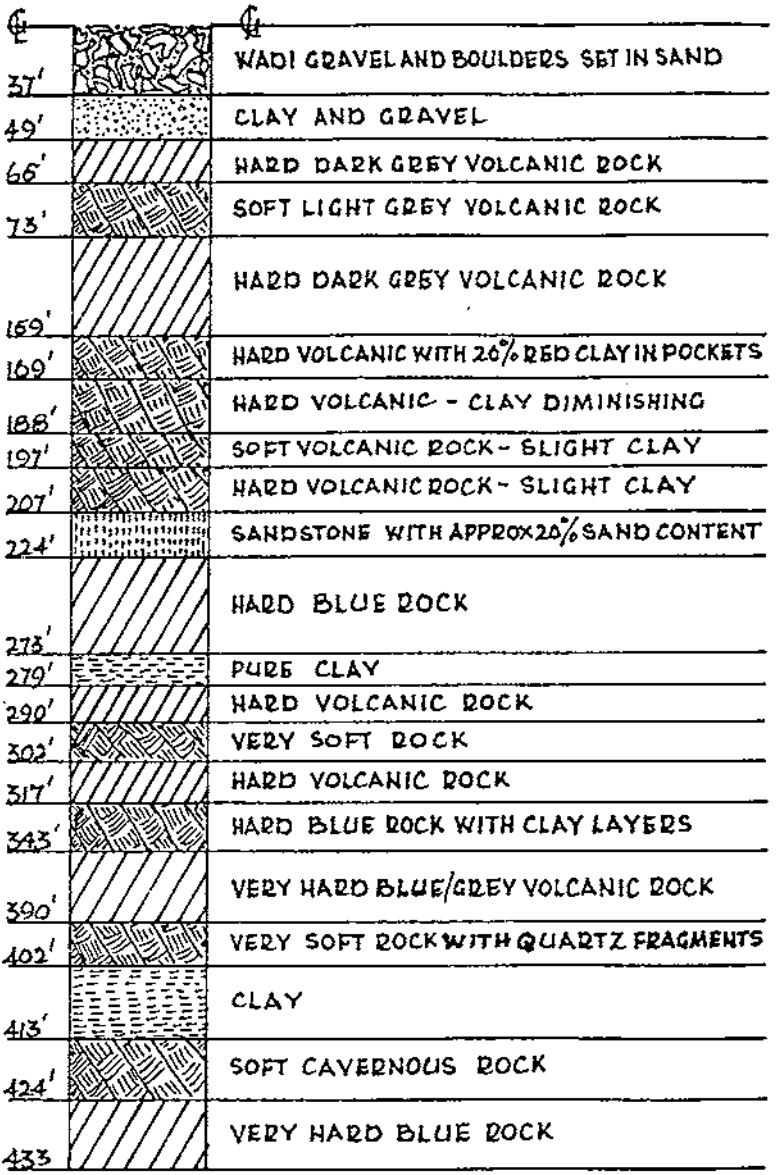

FIG 8: STRATA LOG - NO 11 BOREHOLE

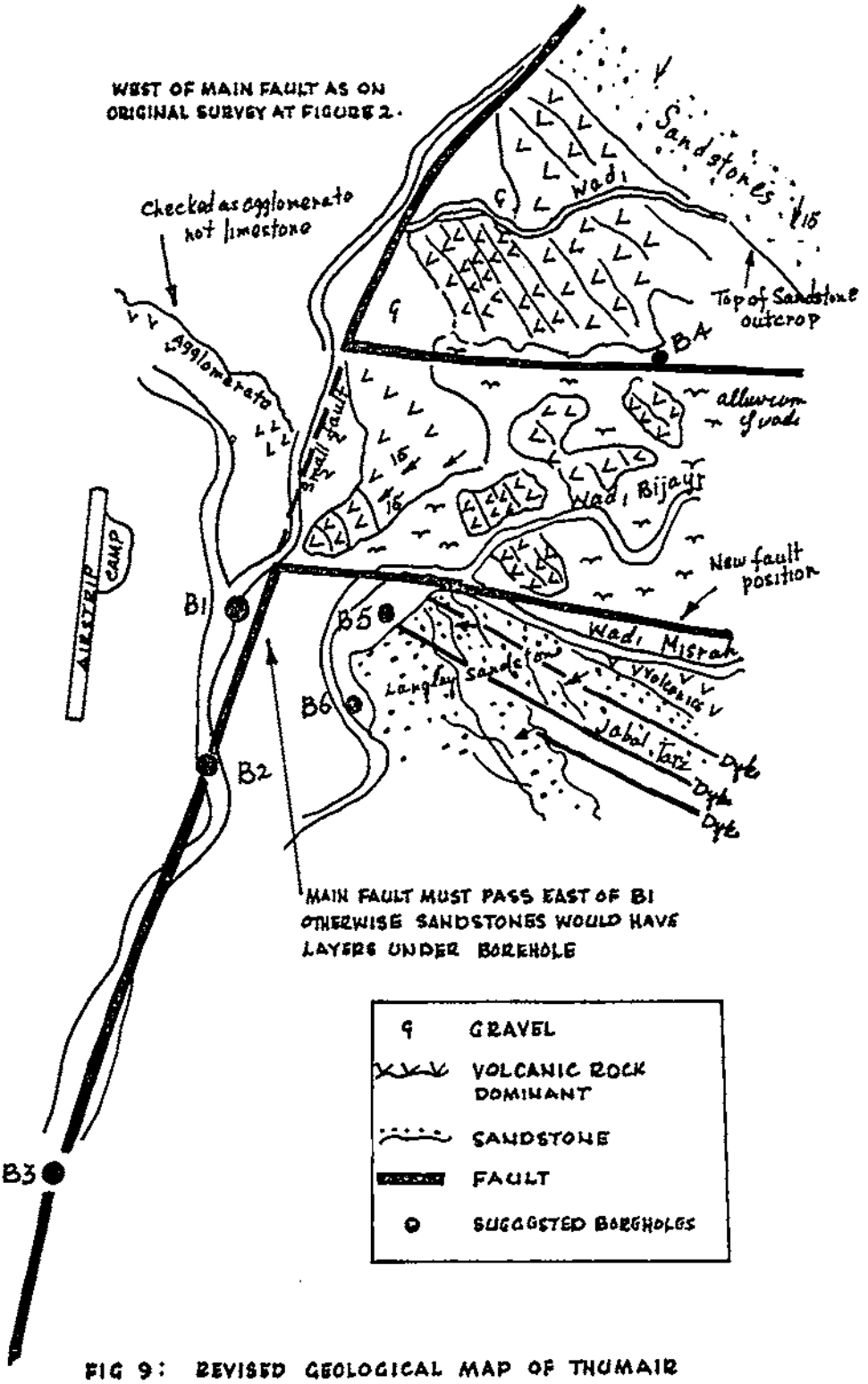

FIG 9: REVISED GEOLOGICAL MAP OF THUMAIR

Dowsing

COLONEL A. H. BELL, DSO, OBE

THE article by Major D. P. Cadoux-Hudson entitled "Detection of Underground Objects by Divining", published in the June 1967 issue of the *RE Journal*, is apt to be misleading, as it may well give the impression that the Royal Engineers have had no connexion with dowsing, nor profited by its application in earlier days.

Such, however, is far from being the case. My first experience of its use occurred in 1903, in the aftermath of the Boer War, when I was building a cantonment for a small body of troops at Pietersburg in the Northern Transvaal. There was no obvious source of water supply, except for a polluted stream about a mile south of the patch of bare veld on which the buildings were to be erected. Trial wells were dug in various places, none of which gave more than a trickle; and thus I eagerly grasped the offer of a local resident who said he was a water diviner and was prepared to find water on a suitable site. This he did successfully, close to the northern boundary of the area concerned.

Owing to a change of policy the buildings were never used for troops, but some were converted for use as a hospital. Many years later I learnt from a doctor, whom I had known when I was stationed there, that the water from my well was still in use.

After a lapse of thirty years, my dormant interest in dowsing was revived by a little book in French, called *Le Sourcier Moderne*, by a certain Vicomte Henry de France, a member of the old French aristocracy and a great friend of our country (as his Christian name implies). As I enjoy a special facility for the production of books in general, I translated this book into English, and it was published under the title of *The Modern Dowser*. Rather to my surprise, it attracted a good deal of attention, and led to a voluminous correspondence with other enthusiasts.

At the suggestion of the Vicomte, with whom by now I was on very friendly terms, a meeting was held in London to discuss the possibility of forming a Society on the lines of that already existing in France. Hence it was that, on 4 May 1933, "The British Society of Dowsers" came into being, and has flourished ever since. Its membership, the total varying between 600 and 700 is not limited to inhabitants of this country, but includes a number of "overseas" members. The necessary link is provided by a quarterly journal which has appeared without interruption since September 1933. Within the last few months the Society has received recognition as a "charity", an admission in itself that its objects are for the general advancement of science.

The Royal Engineers have always played a prominent part in the administration of the British Society of Dowsers and in the practical application of the various aspects of dowsing: one of the three Vice-Presidents, and three of the six members of the Council are retired officers; and of these four only one has not developed the dowsing faculty.

As long ago as August 1934, Brigadier A. J. Edney, CBE, then a captain and an instructor at the SME, under a sympathetic Commandant, the late Lieut-General Sir William Dobbie, devoted two days to the instruction of twenty-four Young Officers in the art of dowsing. In this he was assisted by Major Ralph Creyke, a retired officer of the Scots Guards, and a good natural dowser. A test was carried out at Queendown Warren, near Sittingbourne, Kent, belonging to Mr Faussett-Osborne. Out of the twenty-four tested, nineteen showed more or less aptitude.

Quite recently the idea of testing Young Officer classes and NCOs of the Corps, was approved by the E-in-C (Major General J. H. S. Bowring, OBE, MC), and this has been done by Colonel K. W. Merryless, OBE, a most successful and widely experienced dowser, usually when the classes are on fieldworks, and rather more than 10 per cent have been found to be sensitives who only require practice to become competent dowsers, while about double this number had an appreciable ability.

The last paragraph of Major Cadoux-Hudson's article opens up a wide field for comment.

It is now generally realized that dowsing can be used for "discovery" of any kind, and that electromagnetic radiation has nothing to do with the neuromuscular impulses which the dowser experiences. Dowsing is a very individualistic operation, for which no hard-and-fast method can be laid down; nor can any particular indicator be advocated, such as a forked rod, angle rod, or pendulum. The word "discovery" can be applied to a limitless extent—whether it be an underground stream, its depth and quantity, an archaeological fragment, or the seat of a disease and its remedy; whilst the fact that "locations" are now carried out on maps and plans with a degree of success beyond the possibility of chance, speaks for itself. In fact, it must now be accepted that dowsing is primarily an operation of the subconscious mind, and that the aim of the dowser should be to acquire control of this obscure faculty, and thereby obtain a power of "innate perception", resembling in some respects the "instinct" common to all animal life.

Note: See also letters on this subject in the Correspondence Section. Editor.

The Corps and the Rock Temple at Abu Simbel

BRIGADIER A. B. D. EDWARDS, CBE, MC

THE Rock Temple at Abu Simbel has now been raised 200 ft and thus has been preserved against the flooding which will result from the completion of the Aswan Dam. It is timely, therefore, to recall that a preservation operation was carried out in 1892 by a detachment of 24th (Fortress) Company as the result of an appeal by the Egyptian Government to Army Headquarters.

The detachment of 12 NCOs and Sappers, under the command of Lieutenant J. H. L'Estrange Johnstone, RE, arrived at Abu Simbel by the gunboat *Et Teb* on 6 February 1892. It was found that the slope above was covered with loose debris. A large fragment of rock above the left-hand Colossus of Rameses II was within an inch of toppling over on to it. A still larger piece near another was cracked all round and overhanging. Many smaller pieces were on the point of slipping. Tons of loose rock required attention, and since much of it was partly buried under drift sand and the slope was extremely steep, great caution had to be exercised.

Native workmen were engaged first to make a path up a sand slope north of the façade and along the hillside above. On 10 February a loose block poised on the cornice immediately above the temple entrance was removed by means of tackle attached to a holdfast.

"On the 12th", wrote Johnstone, "a four-inch steel wire rope arrived from Wadi Halfa, and we set to work to make fast another loose rock to a holdfast of steel bars jumped in the level rock above. This rock weighed 70 tons. Had it slipped, or a loose block behind it fallen on to it, it seemed certain that it must be hurled down on to the finest of the Colossi. We got three jacks under the Southern portion, and two turns of cable round the Northern, and after a week's anxious work the rock was broken up.

"On the 23rd we were able to begin the most anxious part of our work, making fast the largest loose rock.

"After strengthening the holdfast with eight steel drills, we wound five turns of cable round the rock and holdfast and made all secure with Spanish windlasses, so that by the 26th we were able to report that all immediate danger was at an end.

"On this day, thanks to the arrival of a theodolite from Halfa, we observed the sunrise on the morning on which the rising sun shines most nearly down the axis of the temple into the inmost sanctuary, where Rameses the Great sits in state with the three gods, Amon, Horus and Ptah.

"The scene of the bright, level beam striking into the gloomy tunnel, lighting up statue and painting 3,200 years old, yet graphic and lifelike, was one never to be forgotten."

On 27 February, while cleaning sand and stones from the rocky face above the cornice and throwing down fragments of rocks which had been broken up, Johnstone discovered a crack severing from the solid cliff an overhanging mass weighing about 650 tons. The party began to demolish this mass, and for the first ten days made excellent progress. On 10 March, however, they encountered a very hard layer.

Although they had no high explosives for blasting, they succeeded in cracking the rock with small charges of gunpowder taken from nine-pounder ammunition in the gunboat *Et Teb*, and by the 18th most of the hard layer had been removed without damage to the Colossi below.

A week later a soft stratum was reached which continued to the bottom of the overhanging mass. As each piece was broken off it was hauled up the slope by a winch and tackle, and at last the dangerous mass was reduced to a block of about 100 tons weight, lying well back from the edge of a flat ledge.

Great difficulty was experienced in dealing with some fragments of hard rock balanced almost of the edge of the cornice, though in the end they were broken up and removed without accident. A few of the monkey figures were repaired with cement, and one was furnished with a new leg.

On 5 April the party began to clear sand away from the entrance to the temple, and to uncover the grave of a British officer on which they had heaped sand to protect it from injury.

On the 9th the work was inspected and appreciation expressed for what had been accomplished. In all nearly 850 tons of broken and dangerous material were removed, working often in a temperature of 107 degrees in the shade, and the cost of the operations had been less than one-half the estimated amount.

Although they had saved the Abu Simbel Colossi from destruction, no official record of their achievement was ever placed at the site. Nevertheless, one humble record of their visit remains. On the outside of the right ankle of the third Colossus from the left is the inscription "Sapper J. A. W. Beal RE 1892".

If it may be taken as a tribute to Sapper efficiency, this inscription was so well done that very little deterioration seems to have occurred during the seventy-five years of exposure to the elements.

A Job of Work

BY BRIGADIER R. A. CHENEVIX-TRENCH, CB., OBE., MC.

The message was signed by the Thesiger of the day in Addis Ababa.[1] It reached me in a cleft stick after a journey of three weeks through the hills. Earth and air reeked of damp and not far away a dead crocodile advertised its presence. The year was 1915, the place Gambela in the western lowlands of Abyssinia. To the east were the foothills; to the west a no-man's land of river, marsh and forest stretched away to the Sudan border and on to the Nile—a forbidding landscape, noisome and malarial, calling to mind lines from Hilaire Belloc's "Modern Traveller:-"

> Beneath his feet there stank
> A swamp illimitably wide
> In which a kind of foetid tide
> Rose rhythmical and sank

The message said that I should on no account fall foul of the local authority, and that if my work were opposed it must stop. The work was to put up a wireless station in Abyssinia, for which no agreement with that government had been reached.

This had all begun for me in the peace and beauty of the Kent countryside in the summer of 1914—I was a subaltern on leave from the Sudan where, in the Egyptian Army, I wore Lieut.-colonel's badges and enjoyed the Turkish rank of Bimbashi and the fabulous pay of £600 a year.

That position calls today for explanation. The Anglo-Egyptian Sudan had been rescued from the blood-drenched, ruinous tyranny of the Khalifa Abdulla by the combined British and Egyptian expedition under Kitchener that ended with the Battle of Omdurman in 1898. Kitchener, with the modest title of Agent, then directed all from his residency in Cairo. He ruled through his advice to the Khedive of Egypt, who still owed fealty to the Sultan of Turkey, the Sheikh-ul-Islam, as his temporal and spiritual overlord. The Sirdar, Sir Reginald Wingate in Khartoum, combined the rule of the Sudan with the command of the Egyptian Army. Its ranks bore Turkish titles and the words of command were in Turkish. The language of all was Arabic. British officers of the army and civil service observed the Moslem holiday on Friday and worked on Sunday, with the concession of time off for church; they celebrated the Khedive's birthday and behaved in general as the Christian servants of a Moslem power. But they did not go so far as to exercise anything less than complete control. Their authority was unquestioned and was still welcomed in the country as a deliverance from chaos with its accompanying famine and depopulation, massacre and enslavement. These officers were recruited by no academic test, but by personal selection, and no-one knowing England will be surprised that many of the civil servants were blues from the older universities. In the higher ranks, homely English names bore the titles of Bey and Pasha and British governors of provinces were Mudirs.

Such a constitution, if it could be called that, would have defied definition, but no one thought of defining it. Our concern was to make it work. Murderous fanaticism, or religious zeal, according to the point of view, was never far from the surface. I had been seconded to the Egyptian Army and lent by them to the Sudan Civil Service as Assistant Director of Posts and Telegraphs, there to learn the work by doing it, with the unfailing help of experienced subordinates.

To return from this digression—the house party where I was a guest more than half a century ago belonged to a lost world. We were told if dinner was to be merely an informal meal calling only for dinner jackets, and on Sunday everyone, host and

[1] The Hon. Wilfred Thesiger.

hostess, guests and servants, trooped across the fields to church. It was at Redleaf in Penshurst, which our host, Colonel (later Lieut-General Sir George) Fowke and his wife, delighted to fill with young guests.

In this elysium a telegram reached me. It was from Khartoum, in cipher, and I took it to London and asked the Sudan Agent what it said. He could not tell me. I tried Scotland Yard, and drew blank. Study in the train on the way down showed it to be in the simplest of transposition ciphers, arrived at by taking the most frequent letter in the message as e in the alphabet. It asked what it would cost to establish wireless communication between Malakal on the White Nile, about 450 miles south of Khartoum, and Gambela, 220 miles away in Abyssinia, where the Sudan leased a small trading post and had a commercial agent. This would give the Abyssinians a telegraph outlet to the world through Egypt and rescue them from dependence on the Italian telegraphs through Eritrea. An intermediate station was wanted for an Egyptian Army outpost at a place called Nasir. Naturally enough I did not know the answer, but a Royal Engineer must not be at a loss: if they wanted a figure they should have one. I cabled back a certain sum in the same schoolboy cipher, and with better things on my mind I forgot the matter; but not for long. A further telegram instructed me to buy the stations and install them. That was the end of my leisure.

In those days wireless sets, other than those for ships, were not to be bought ready made: they must be designed for their purpose. These sets would be installed, worked and maintained by men who had never seen a wireless set. Those at Gambela and Nasir would be out of reach of repair shops and must be as nearly indestructible as possible. I visited establishments of the Royal Navy, the Army and civilian firms that were grappling with the new problem of wireless communication. A design was worked out with their help and the parts were ordered from various firms, to be sent to Khartoum for assembly. This was before the thermionic valve had replaced the spark and a description of the sets would now be of interest only to the antiquary. Portability did not matter and they had a massive, archaic simplicity.

There was then little wireless communication in the world and interference had hardly raised its ugly head. We thought in wave lengths rather than frequencies and the short waves of today were not favoured, for how would they get round the corners or over the mountains? The idea of bouncing them off the sky had occurred to no one. We lived, in fact, in an age of innocence, though such a view would have surprised us. Lavish power and high masts were the thing if we would be sure of getting through. So, for the prime movers, low speed eight horse power petrol engines were settled on, with 90 foot masts for the aerials. Special precautions were necessary to discharge harmlessly to earth the formidable voltages that would accumulate during the tropical thunderstorms.

I returned to Khartoum in June to await the components and report to my chief. He was then Major J. P. Moir, RE, a Kaimakam and a Bey in his Turkish metea-morphosis. He was a tremendous worker himself and a hard driver of others, a "ragul shadeed" in the local Arabic, feared and therefore respected by Egyptians and Africans alike, someone they could understand and appreciate. War broke out in Europe, but our pax Britannica was broken only by the desperate struggles of the British officers, by fair means or foul, to get to France before it should all be over (probably by Christmas).

It was 1915 before the gear began to arrive. While waiting for it I visited Gambela with Sergeant G. A. Stevens, who was to be my assistant in the whole enterprise. He, like the others, had to learn about wireless as he went along. The life line of Gambela was the Baro River, which became the Sobat River lower down, joining the Nile at Taufikia near Malakal. It meandered endlessly, doubling and redoubling on itself through the swamp, with forest on either side, sometimes in the distance, sometimes touching the river bank. Pelicans, gliders par excellence, soared magnificently overhead or descended to the water to make a faultless landing up wind,

with feet stuck out in front to put on the brake. It was easy to tell, going up river, when one had left British administered territory and entered Abyssinia, because there the villages, each on its strip of land just above flood level, were stockaded from bank to bank against slave raiders from the hills and tribal enemies. The settlements of the riverine tribes, Dinka, Shilluk, Anuak, Nuer, were separated by wide stretches where few ventured. They were cattle owners and cattle lovers, counting their herds as symbols of wealth.

Few people outside the Sudan had heard of Malakal, but on the opposite, the western side of the Nile was a spot called Fashoda, which in its day had held the strained attention of the world, for it nearly led to a war between Britain and France. The affair may by now be worth recalling. Captain Marchand had left the French Congo with a small force in 1896 and after a historic march across tropical Africa had reached Fashoda in July 1898 and built a fort there. The French were thus established on the Nile and the fort announced its presence by firing on a steamer of the Khalifa, going south to collect grain for the Dervish army. News of this reached Kitchener just before the battle of Omdurman on 2nd September, and on the 8th he set off with five steamers and a considerable force to deal with what he might find. This show of strength, combined with good manners, tact and respect for the French achievement, prevailed to avoid a fight. The matter was referred to the two governments and happily settled. The gallant Marchand and his force withdrew into the wild and Kitchener gave one of the officers free passage down the Nile to report to the French government.

For six months in the year there was enough water in the Baro to float a stern wheeler, and a boat went up once a month. For the rest of the year Gambela was inaccessible. By the last boat of 1914 Sergeant Stevens and I went up and marked the places for the masts and the corners of the buildings with stone cairns that could be found next year in the grass and jungle. It was there that I came upon a Maria Theresa dollar in circulation.

Back in Khartoum, plans had to be made for the 90 ft masts. Some 60 ft and 40 ft poles were found in Cairo and it was decided to use these, with the 40 ft pole stepped like a topmast and a 10 ft overlap at the hounds. White ants would have made short work of wooden poles in the ground, so the butt end of each mast was to be bolted between two vertical channel iron girders, which would hold the wood a foot above the surface.

Early in 1915 we were again at Malakal, this time with Mr Seabright of the Public Works Department. The masts had been towed up the Nile lashed alongside the stern wheeler that carried the black working parties. They were set up there and the buildings constructed, and my companions went up by the first boat of the year to do the same at Gambela and Nasir, while I stayed on at Malakal to install the instruments and follow by the next month's boat.

When I rejoined them at Gambela they were glad to see a friend, for they had had a trying time. As soon as the boat had gone down, leaving them marooned for a month, the local governor appeared and asked them what they were doing in his province. They replied politely that they were putting up a wireless station. "Not here, you're not" he said in effect. He was a Syrian adventurer called Majid Aboud, ruling in a lawless, remote hinterland, which he farmed in the traditional style. Those swampy lowlands were shunned by the Abyssinian hillman and left practically unadministered. The Emperor's writ did not run there and with Majid's connivance a shady traffic throve in illicit ivory, smuggled rifles and black slaves, while bandits at the fords took toll from travellers. Like other border barons he preferred the old fashioned ways, and he looked coldly on the marvels of modern science that would bring the world to his door. The telegraph line to Addis Ababa was a bare wire fixed to the trees of the dripping forest and it seldom worked. He called himself Sultan and said he would have no interference from anyone.

I did not like him and wrote in a letter home "This particular province is farmed out to a gentleman called Majid Aboud, a Syrian Turkish subject, pro-German and

a most poisonous swine. He makes what he can of it, remits a certain amount to Addis Ababa, and no questions asked" and "What fetched me more than anything else was his claim to arrest and tax inside our enclave and his refusal to recognize any boundaries."

In opposing the Englishmen he had an ally in an Austrian, an enemy subject, who hovered in the background. He gave it out that the masts would strike the village with lightning, and were, in addition, put there in readiness for the arrival of a British army, which was coming to annex their land, as they did everyone else's. He did his best to provoke a fight and indeed Stevens was at one time moved to send his servant for his rifle, but Seabright, the senior man, checked him. Seabright was a big man and had been a sergeant in the Royal Marine Artillery and Captain of the Foretop. In an encounter with the commander of the local Abyssinian soldiery he had so intimidated him as to establish a personal ascendency that was never lost. In spite of Majids prohibition he quarried building stone from a hill a mile outside the boundary.

Stevens had a medicine chest well stocked to deal with the common ailments of the country. His fame spread and patients came from villages far down the river. He was immensely popular and introduced me to the leading local man, Alto Gabri, as a special friend of his. He unwittingly secured the protection of the powers of darkness. Sitting up on the roof of the engine shed to wait for a leopard that had been passing nightly, he gave up in the small hours, stood up and stretched, waving his arms and groaning with stiffness. A local party on their way home after a night of drinking happened to pass, and the devil haunted station was shunned from that day.

A little more about Stevens is appropriate before returning to the main theme. From the deck of the steamer on the way down from Gambela, he and I saw in one village a scene of unusual activity. Girls ran along the bank waving wildly. They were former patients of his and had recognised him on the deck: he was delighted to see them again and knew all their names. As the boat drew clear of the village three of them, naked of course, stood in a row and saluted, as he had taught them to do in Gambela when they came to his hut for treatment. Once, when seeking meat for a working party, he wounded a roan antelope: he followed the blood trail through the grass: it stopped, and there on his right hand, his roan lay on the ground. Over it stood a lion. Stevens swung round in panic and fired from the hip. The lion, shot through the brain, fell dead across its victim. Reasoning rightly that his story would not be believed, he walked back to camp, got out his camera, returned to the kill, drove off the vultures and photographed the scene. From time to time he would say in delight "We really are in the wilds now aren't we Sir", and his letters to his parents on their farm in Buckinghamshire would have been worth reading. I read some years later that he had died of sickness, engaged on some wireless project with the French in Tibetsi.

To return to Gambela and the Abyssinians; British officers who had to deal with them met an invincible conceit and ignorance of the world beyond their mountains, which made them difficult to talk to. The Abyssinians felt themselves in no way inferior to Europeans. Had they not defeated Turkish and Italian armies sent against them in the past? But they had been soundly beaten by Sir Robert Napier in 1868 and a prestige invested the English, both on that account and, perhaps more, for their name for speaking the truth. Mysteriously, inexplicably, they did what they said they would do. Our two men, untroubled by doubts, saw themselves simply as obeying their orders. This, and the daunting assurance with which they set about their work, carried them through; but the month of isolation had been a strain and they were ready to hand over responsibility. They had tried to get a man in a canoe down the river to report their plight to me but from a vantage point on the bank Majid's men had turned back all travellers.

The captain of the steamer agreed to keep her there for three days, while we worked day and night to install the instruments. It was done, the engine was started,

the key was pressed and communication was opened. We received on the same day Sir Reginald Wingate's congratulations by wireless and Thesiger's warning by runner. To Majid I sent a request that he would honour me with a visit, taking care to address him with the formal courtesies due to his position. He replied in kind and came in state with his body guard, his ceremonial sword bearer, rifle bearer and target bearer, wearing his robe of honour and a full cartridge belt. We held a mejlis, for which my Arabic just sufficed, though an interpreter in Abyssinian Amharic was at hand. Majid was shown over the station and saw the spark, the *afreet*, leaping and roaring in its little box. He declined, like a shying horse, to send a complimentary message to his opposite number, Colonel Woodward, the Mudir of the Upper Nile Province, at Malakal. "God forbid" he said piously.

I congratulated him on the prospects of improved trade now that the merchants were in touch with their market: he agreed, with marked lack of enthusiasm. I spoke of his threats to Seabright and Stevens, for which he would be called to account in Addis Ababa. He was slippery and evasive, reluctant to agree to anything, but over cups of Turkish coffee a modus vivendi was reached and he assured me that, now the station was up, he would not interfere with it. I let the steamer go with sincere thanks to the captain for disrupting his department's timetable. It was gratifying later to hear of a prisoner for debt, brought before Majid in chains. On learning that he worked for us, Majid said "Oh, for God's sake, let him go".

A tribute is due to the Egyptian operators, town-dwellers all, exiled in a distant, hostile land, demon haunted, infested by naked, warlike savages and wild beasts, fever stricken and full of unknown terrors. For company they would have no urban neighbours, but the customs officer, the commercial agent and the inevitable small Greek trader, the "Graeculus Esuriens" of Juvenal, to be found all over north and east Africa where there was money to be made, penetrating wild places and facing great dangers in its pursuit; there were a few dealers who accumulated hides and gum and other local products to exchange for cottons, cheap Birmingham goods and other western merchandise brought by the steamers. There was a Tasmanian adventurer who flitted in and out from time to time.

I have referred to Sudanese working parties. Many of these were Jehadieh, men who had fought against us in the jehad, the holy war, until they were broken at Omdurman. Between these black Africans and British officers and NCOs of the department there was a strong bond of union. Both races shared a basic, unrefined, simple idea of a joke, in which bodily discomfiture was generally an element, and if drunkeness somewhere came in, so much the better. There was in Gambela a man with only one foot, who explained his plight "Yes, a crocodile had me by the foot and would have devoured me: he pulled one way and my brethren pulled the other, but Allah was merciful and gave to the crocodile only my foot". They were always smiling and friendly, with broad, shining ebony faces, sometimes grotesquely ugly: we referred to them with affection as "black nuggets", though some white women complained that they gave them the creeps.

At Gambela, commemorated by a stone tablet, lay the body of Major-General Sir William Gatacre, the "Backacher" of the British troops in the South African war, where he had fared so badly. On his retirement at the age of 60 he sought employment and an outlet for his energies, and joined a trading syndicate under Greek management in the Sudan, who rightly valued his name on their paper as Director. They had interests in Gambela and he decided to visit the place. On his way up the Nile from Khartoum he travelled 2nd class in the boat, along with the Greek traders, to the horrified amazement of the black ex-soldiers at the stopping places, who recognized him as the General who had commanded the British brigade in the storming of the Dervish zariba at the Atbara, eight years earlier. As he steamed up the Baro the river level dropped and left his boat stranded. Indomitable, he started to walk, with his Indian bearer, and perished on the way of hardship and fever. It was said that he was ill equipped for the journey, and slept on the ground without camp bed or mosquito net, and the biography, written by his widow, quotes an entry

from his diary for January 11th, 1906, shortly before his death "Camped in a swamp —horrible water". The Tasmanian whom I have mentioned saw him where he lay, thought he must be a drunken Greek and passed by. Word of his plight reached Gambela and the stout hearted Egyptian Mamur in charge collected a party, forced them to accompany him through the unknown perils of the way and brought the body in for burial.

On a subsequent visit with Colonel Woodward we were accosted by a little man, clearly not a native, who salaamed in Indian fashion and made his petition, repeating in bad Arabic "My master is dead; my master is dead". His delight in being spoken to in Urdu by Woodward was moving. He had been Gatacre's bearer, and could we, please, get him out of this horrible country before he died. Woodward took him under his wing and started him on his long journey back to the Punjab.

The wireless sets were now, I hoped, safely installed, but I was wrong. The wax-insulated condensers that I had specified for the closed high frequency transmitting circuits were not man enough for the job, and they melted. They were replaced by condensers made up from material found in the Public Works Department in Khartoum—sheets of builders' zinc sandwiched between panes of window glass, placed in glass accumulator jars and immersed in lubricating oil. They worked well and gave in good measure an impressive pyrotechnic display of brush discharge, gratifying evidence of the imprisoned djinn. Later, when a fire had destroyed much of the ebonite insulation at Malakal, silk ribbons were used to suspend the copper in mid air within wooden frames. They were found at a ladies' outfitter in Khartoum, and on his note of anti-climax the job allotted to me was finished.

I learnt later that rumour of Majid's doings had reached Addis Ababa and that he had been summoned there to give an account of his stewardship, with many enemies anxious to inform against him. Menelik's arm was longer than had appeared. And so the story ends, with the success of the venture and the discomfiture of the villain, as all stories should end.

Correspondence

Brigadier R. A. Barron, BA,
Headquarters,
Northern Command,
York.

The Editor,
RE Journal

13 June 1967

AHMED'S PARABLE

Dear Sir,

As one who took a close interest in the upbringing of Ersalt before he achieved his confirmation, and changed his name to Ahmed (*RE Journal*, June 1967), may I mention one aspect of his family relationship which may be of historical interest, if nothing else.

At that time—a baker's dozen of years ago—the family was very dubious about Ersalt, and wondered whether he was really worth bringing up at all. He seemed to have expensive ideas, and there were patriarchs who thought that Ersalt merely lolled around looking beautiful, without contributing very much to the family well-being.

As I thought otherwise, it seemed to me that the best thing to do was to consult his friends. At the time, Ersalt was living in Wiltshire and, not very far away, there existed—and still exist—schools run by three of his friends: Tancore (whom we have met before), Gunah and Futsoljah; together with another school, which members of his own family sometimes attended, called "Ceniaophisars".

At my invitation, the headmasters of all these schools very kindly came to Ersalt's home, for long talks about his future and about every detail of the way he should conduct himself. They, together with some other senior members of Tancore's and Futsoljah's families, all agreed that Ersalt could be most helpful to them and should definitely not be cast out by his own family.

This, of course, I reported to the family. The fact that shortly afterwards Ersalt suffered partial emasculation at the hands of the family may therefore seem surprising. This was only mitigated by the fact that Ersalt—or what remained of him—was moved to a new home in Germany, where he was able to play with his friends and to prove how right they had been. From that point on Ersalt—or now Ahmed as he had become—was more or less accepted by the family, though he is probably still more popular with his friends than with some members of the family.

I whole-heartedly agree that all members of the family should be educated in Ahmed's qualities. Wherever, at least, Tancore is to be found, Ahmed must be there as well. If that education happens to lead to his fragmentation amongst other members of the family, at least he will not have lived in vain and those other members will be the better for it.

If there is a lesson for the future in this reminiscence perhaps it may be that the family must never contemplate ignoring the opinion of its friends, and that it must always seek that opinion particularly when the friends are deeply involved.

Yours faithfully,

R. A. BARRON

United Kingdom Atomic Energy Authority,
Atomic Weapons Research Establishment,
Aldermaston,
Berkshire
29 June 1967

The Editor,
RE Journal

DETECTION BY DIVINING

Dear Sir,

Major Cadoux-Hudson's article in the June *Journal* comes at a time when the Corps is taking a keen interest in water divining.

In 1962 I was introduced to a commercial device called the Revealer, which in essence consisted of the two L-shaped wires used by Major Cadoux-Hudson. One substantial difference was that the firm marketed its Rolls-Royce version at approximately £70.

The right-hand rod of the Revealer carried a range of minerals to identify the nature of the buried object in the manner described in the article, once it had been located. The effect was that the rods failed to cross when the matching substance was carried in the right hand. Paradoxically, for the location of vegetable matter it was claimed that if a sample of the matter was held in the *left* hand it would cause the rods to cross, i.e. one hand acted as a simple detector of vegetable matter, but the other was able to discriminate in the case of minerals.

At that time the Revealer device was used by British Railways, though I was told that one Region had been forbidden to use it because of the absence of any scientific principle. During their visit to Southern Region at least one RE Long Transportation Course saw it being used to trace underground cables. I also saw it used by the chief engineer of Southwark Borough Council to trace a concrete culvert in a children's playground.

If I still needed convincing that some people are gifted as dowsers the opportunity came about two years ago, when an Australian Corporal in 11 Independent Field Squadron, Malaya, was invited by a Malayan rubber company to find water on one of their dry estates. Although we never heard the detailed results of his attempts, we subsequently received a cash gift to the unit PRI, so we assumed that the customer was satisfied.

Major Cadoux-Hudson suggested possible causes for the phenomenon, but if there is an underlying scientific principle it is not yet properly understood. During TSO tours of duty I have had opportunities to try to persuade scientific staff to undertake research into the phenomenon, but it is a curious fact that in this age of rapid scientific advancement no one seems willing to probe further into a problem which has defied scientific explanation for so long.

Interest now being displayed in the Corps may yet spark off a scientific study which could have far reaching results.

Yours faithfully,

G. J. CHAVE, Major RE.

Major G. E. C. Woollatt, RE
CRE(Ops) FARELF/HQRE 17 Division,
Tanglin Barracks,
c/o GPO Singapore.

The Editor,
RE Journal

18 August 1967

Dear Sir,

Before the majority of your readers dismiss Major Cadoux-Hudson's article with that peculiar brand of cynical disbelief that is reserved for unexplained phenomena and demonstrations bordering on the occult, I would like to add my support to his findings.

I cannot, from my own experience, be quite so precise or scientific as Major Cadoux-Hudson in determining the exact depth of objects or in differentiating between the various metals, voids and water. I personally find that by the time the wires cross over I am some feet past the object. I have not been able to establish any constant relationship between the distance and the depth of the object located. However, despite this limitation I saved myself a pound or two as a troop commander by finding odd bits of G 1098 equipment lost by soldiers in dense undergrowth and swamps.

Incidentally the phenomenon, call it what you will, is by no means a new discovery. It was first brought to my attention on a YO course at Chatham by the E & M School who were then teaching it as a standard method of finding underground cables. I clearly remember our class solemly parading up and down outside the old E & M School with two pieces of L shaped wire in our hands, all feeling rather foolish until we discovered that it worked. We also discovered that the wires indicate the presence of overhead cables as well as underground objects. Looking even further afield, Terresearch, the soils mechanics department of Taylor Woodrow, use a commercial version of the "equipment". This comprises a pair of insulated handles with a ball bearing mounting at the top into which a variety of rods of different lengths and, if I remember correctly, different materials can be fitted. The fact that a civilian firm has this equipment in commercial use should surely silence all but the most persistent sceptics.

Yours faithfully,

G. E. C. WOOLLATT

Major-General W. G. Fryer, CB, CBE,
c/o The Warminster Press Ltd,
Station Road,
Warminster, Wilts.

The Editor,
RE Journal

5 July 1967

Dear Sir,

With alarm I see that divining is being seriously put forward in the *RE Journal* as a way of locating hidden water or hidden metal.

I think is should be known by all Sapper officers that:

(*a*) Most water-supply textbooks of repute include remarks such as, "Scientific tests of diviners have shown that the method is valueless as a way of locating unknown water."

(*b*) The tests conducted by Professor Andrade for the Director of Bomb Disposal during World War II showed no ability to locate hidden metal by divining.

(*c*) Water divining failed miserably as a way of locating water in the Libyan desert in World War II. Geologists and geophysicists carried away the honours in locating desert water. I had the closest view of this experience. The geologists were surprised to find that their efforts were reported in home newspapers as water-divining successes. This seems to result from the journalist's belief that a water-divining story is news while a geological story is not, and so the man in the street hears the divining story and nothing else. Like flying saucers.

It does seem most important, when testing diviners, to ensure that *nobody present and in view* knows the location of the hidden test object. In my experience many diviners seem able to locate objects whose position is known to eye observers. But how they fail when dealing with unknown locations!

The serious danger for any water engineers who use diviners is that the diviner's witch-doctor technique fogs or prevents scientific geological consideration of underground water flow and storage conditions on site. Is it time that a competent geologist gave an RSME

lecture on how water really can be located by the latest modern scientific engineer techniques of geology and geophysics? Can we back witch-doctor science in our official *Journal* any longer?

I accept the fact that diviners are sincere in their belief in their ability to locate hidden objects. They certainly get reactions of various kinds. But in my experience this tells nothing of the position of *unknown* objects—*unknown to eyewitnesses.*

Yours sincerely,

W. G. FRYER

CENTENARY OF THE ROYAL NEW ZEALAND ENGINEERS

Lieut-Colonel K. C. Fenton, RNZE, has sent the following personal notes on Colonel T. M. Haultain and Major C. Heaphy quoted in his article published in the June 1967 issue of the *RE Journal:*—

Colonel Theodore Minet Haultain was Minister of Colonial Defence in New Zealand from 1865 to 1869.

Born in 1817 at Stoney Stratford, Buckinghamshire, the son of Lieut-Colonel Francis Haultain, RA, and Eliza (*née* Deane), his ancestors were of Dutch extraction who had come to England with William of Orange in 1688. He entered the Royal Military College, Sandhurst, at the age of 14; he was commissioned at 17 and spent ten years foreign service in India. He brought the 8th "Fencibles" to New Zealand in 1849, but relinquished his Imperial appointment in 1857 and took up land at Mangere, Auckland. When the Taranaki War broke out he organized the Auckland Militia. He commanded the 2nd Waikato Regiment in the Waikato campaign in 1863, and was present at the Battle of Orakau in April 1864.

He was elected Member of Parliament for Franklin in October 1864 and in 1865 became Minister of Defence. His administration was characterized by vigorous measures, and he directed operations of the Colonial Forces on both the east and west coasts of the North Island. While Minister of Defence, he personally conducted operations in the vicinity of Tauranga in early 1867 and accompanied the expedition against Ake Ake and Taumatu villages in February 1867. He was later compelled to retire from active service when stricken with rheumatic fever.

Major Charles Heaphy was born in London in 1820, and in 1839 he embarked for service as a draughtsman with the New Zealand Company.

He is remembered in New Zealand as an artist, explorer, surveyor and soldier of note. In 1859 he joined the newly formed Auckland Rifles Volunteers as a private and later he was elected Captain in No 3 (Parnell) Company. He was awarded the Victoria Cross for gallantry when in charge of a party of soldiers of the South Lancashire Regiment and the Royal West Kents in a skirmish against the Maoris on 11 February 1864. He was the only Colonist to be recommended for the award. The actual award, however, was not made until three years later, it being first necessary to introduce special legislation to alter the Victoria Cross Warrant which at that time restricted the award of the Cross to regular Service personnel only. His citation, published in the London Gazette of 8 February 1867, read:

HEAPHY, MAJOR CHARLES

Date of Act of Bravery: 11th February, 1864 (New Zealand)

For his gallant conduct at the skirmish on the banks of the Mangapiko River, in New Zealand, on the 11th February, 1864, in assisting a wounded soldier of the 40th Regiment, who had fallen into a hollow among the thickest of the concealed Maoris. Whilst doing so he became the target for a volley at a few feet distant. Five balls pierced his clothes and cap, and he was wounded in three places. Although hurt, he continued to aid the wounded until the end of the day. Major Heaphy was at the time in charge of a party of soldiers of the 40th and 50th Regiments, under the orders of Lieut-Colonel Sir Henry Marsham Havelock, Bart, VC, CB, the senior officer on the spot, who had moved rapidly down to the place where the troops were hotly engaged and pressed.

On the termination of the Waikato War he held office as Chief Surveyor of Auckland and from 1869 to 1872 he represented Parnell as its Member of Parliament.

The Lieut-Colonel Sir Henry Marsham Havelock, mentioned in Heaphy's citation, won his Victoria Cross when a subaltern in the Lincolnshire Regiment on 18 August 1857 for daring gallantry in face of the enemy at Cawnpore during the Indian Mutiny.

Contemporary photograph of Major (later Colonel) G. de C. E. Findlay, VC, MC*, taken from the Victoria Cross Album, kept in the Royal Engineers Museum, Chatham

Major G. de CE Findlay VC MC

Memoirs

COLONEL G. de C. E. FINDLAY, VC, MC*, DL

George de Cardonnel Elmsall Findlay, one of the last five[1] surviving Royal Engineer holders of the Victoria Cross, died suddenly on 26 June 1967 at his home, Drumforth House, Helensburgh, Dunbartonshire, aged 77 years.

The son of Rober Elmsall Findlay, DL, of Boturich, Balloch, he was educated at Harrow and the Royal Military Academy, Woolwich, and commissioned into the Royal Engineers in January 1910. From then until the outbreak of war in August 1914 he completed his Young Officer training and served at Chatham in the 5th Field Troop and as Assistant Adjutant for Musketry.

His war service was exclusively on the Western Front and for the most part with the Territorial Sappers of the 409th (Lowland) Field Company RE, TF, which, with the regular 23rd and 26th Field Companies, formed the 1st Divisional Engineers. He won his Victoria Cross on 4 November 1918, one week before the eleventh hour of the eleventh day of the eleventh month when silence descended over the Flanders battlefield. He was then in command of the Company engaged on a Divisional assault crossing of the Sambre-Oise Canal. He had earlier won the Military Cross during the Passchendaele Battle and a bar to it during the offensive against the Hindenburg Line. He was mentioned in despatches three times.

He became Adjutant of the 52nd (Lowland) Divisional Engineers after the war, and in 1924 he was given command of the 59th Field Company RE, then stationed at Catterick. From there he was posted to Liverpool as DCRE (Works).

The next five and a half years were spent in India in Military Works appointments at Dehra Dun and at Karachi and then with the QVO Madras Sappers and Miners at Bangalore, first as Assistant Commandant and later in command of the Training Battalion.

Returning home on sick leave in January 1934, he became in October of that year CRE Highland Area, with his Headquarters at Perth. He retired in June 1938 but was re-employed in a Colonel's appointment on the outbreak of war. After a second retirement in 1940, due to ill health, he was again re-employed from 1943 to 1946, and he served in Italy with the Allied Military Government.

He was a Dunbartonshire County Councillor from 1941 to 1964 and in 1957 he was appointed a Deputy-Lieutenant of the County. In 1959 he married Nellie Constance Barclay Clarke of Connella, Cardross.

All who read this Memoir will know the oft-told story of the memorable and unforgettable day when three Sapper Victoria Crosses were won at the storming of Delhi on 14 September 1857, how two young officers (Home and Salkeld), Sergeant Smith and two other British NCOs, Bugler Hawthorne of the 52nd Foot and a handful of loyal Indian Bengal Sappers just after sunrise ran forward in face of "heavy and destructive musketry fire", crossed an almost completely destroyed drawbridge over a deep moat, placed powder bags against the Kashmir Gate and blew its right leaf, thus opening a way for the assaulting column.

Very few, however, probably realize that just over sixty years later, on 4 November 1918, three other Sapper Victoria Crosses were won during the course of one day in actions equally desperate at the assault crossing of the Sambre-Oise Canal. The recipients were Major A. H. S. Waters and Sapper A. Archibald, both of the

[1] The four survivors are now:—

His Honour Sir Brett M. Cloutman, Kt, VC, MC.

Brigadier C. G. Martin, VC, CBE, DSO.

Lieut-General Sir Philip Neame, VC, KBE, CB, DSO, Colonel Commandant RE (retd) and Past President Institution of Royal Engineers.

Colonel Sir Arnold H. S. Waters, Kt, VC, CBE, DSO, MC, DL, JP, MIMechE, Past President IStructE, MInstWE, FGS, MConsE.

218th Field Company, and Major G. de C. E. Findlay, commanding the 409th Field Company. Two days later Major B. M. Cloutman of the 59th Field Company won the last of the seventeen Victoria Crosses of the First World War awarded to Royal Engineers, at Pont-Sur-Sambre. Surely few other Corps or Regiments can surpass that concentrated recognition of gallantry in face of the enemy over a period of three days.

Before Delhi, Taylor and his youthful Sapper officers were engaged each night in scrambling through the enemy-patrolled thick undergrowth of the Ridge and the deep moat protecting the city's fortified walls to assess the practicability of storming by escalade the breaches in the curtain wall, caused by the bombardment of siege pieces labouriously placed in batteries built for them by the Sappers' blood and sweat, and the feasibility of carrying the Kashmir Gate by *coup de main*.

Before the assault crossing of the Sambre-Oise Canal, firmly held by the Germans, the Field Company Commanders of the 1st Divisional Engineers and their young Sapper subalterns nightly carried out equally hazardous reconnaissances to confirm on the enemy-dominated ground measurements and other essential details of the Canal and its associated dikes and walls revealed by air photographs.

The key point of the Division's assault crossing was a lock two miles south of Catillon across which a 22 ft span tank bridge was to be constructed by the temporarily attached Australian 1st Tunnelling Company, once the lock had been forced and the crossing was firmly in our hands. The assault floating bridge equipment available was a motley collection of bridges, fabricated from captured German steel floats and from locally procured petrol tins, barrels and cork. There were also wheel-mounted single-span infantry assault bridges to cross the lock and other dry gaps, and the Sappers of the 23rd Field Company (shades of Delhi) carried forward forty-eight scaling ladders! Later, to consolidate the crossing, there were floating pack transport bridges and bridges to carry horse-drawn guns and pontoon equipment required for a further advance.

The all-important lock was in the 409th Field Company's Sector of the Canal, and to ensure its forcing the Company was given the task of building eight infantry bridges over a dike on the near side of the Canal, four first-wave infantry bridges over the lock itself and four more supplementary bridges over it, six pack transport bridges (two for each dike and two for the lock) and eight footbridges for the dike on the far side of the Canal.

At zero hour, 0545 hours 4 November 1918, the Sappers of 409th Field Company did not rush forward with powder bags as did Home's assault party sixty-one years before, but struggled onwards, humping their heavy, clumsy and unmanoeuvrable loads, following close upon a creeping barrage ahead of the assaulting infantry of the 2nd Royal Sussex. Within a few minutes a German barrage came down on a line to the west of the Canal, killing and wounding many of the Sapper bridge-carrying parties, and machine-guns opening up from concealed positions added to the losses. The dike on the near side of the Canal proved to be a more serious obstacle than expected and some of the bridges, intended for the lock, had to be used to cross it. Close-range, heavy and destructive machine-gun fire from ruined houses near the lock took a dreadful toll of the Sappers and of the 2nd Royal Sussex, and only one bridge reached the lock. It was laid across at 0605 hours by Major Findlay, two of his NCOs and some men of the 2nd Royal Sussex, the rest of the bridging party having become casualties. Major Findlay had himself been wounded, but, despite this, carried on and was the first person over the lock, and he and his two NCOs rushed a German machine-gun post on the far side.

The infantry then silenced the machine-guns in the lock-house and the assaulting troops of the 2nd Royal Sussex and the 2nd King's Royal Rifles began crossing over the lock. Meanwhile other assault bridges were brought up, and by 0635 hours there were six foot bridges over the lock. At 0745 hours the two pack bridges for the lock arrived, together with the pack mules of the 2nd Royal Sussex. These bridges were built by the few remaining Sappers of the 409th Field Company, ably

helped by men of the Royal Sussex, and completed by 0830 hours. At about this time the Australian Tunnellers arrived, bringing up the 10 in by 5 in steel joists and the 9 in by 3 in decking for the tank bridge. By now the Germans realized that the lock was in our hands and started shelling it with heavy artillery. The building of this bridge under intense shellfire demanded the greatest gallantry on the part of the Australians, but by almost superhuman effort, and at great loss, they completed the task by 1030 hours.

Finally the bridges across the dike on the far side of the Canal were completed and a detachment of the 26th Field Company was sent to help the depleted 409th Field Company maintain the bridges in their sector.

At 2200 hours that night, sixteen and a quarter hours after zero hour, Major Findlay was at last able to leave his post and to count the cost of the operation. Of his officers all were either dead or wounded, and over a half of his men engaged in forcing the crossing were casualties—a grim evidence of the gallant performance of this fine Territorial Sapper Company.

The words of his citation for the Victoria Cross speak for themselves:—

"For most conspicuous bravery and devotion to duty during the forcing of the Sambre-Oise Canal at the Lock, two miles south of Catillon, on 4th November 1918, when in charge of the bridging operations at this crossing.

"Major Findlay was with the leading bridging and assaulting parties which came under heavy fire while trying to cross the dike between the forming up line and the lock. The casualties were severe, and the advance was stopped. Nevertheless, under heavy and incessant fire he collected what men he could and repaired the bridges, in spite of heavy casualties in officers and other ranks. Although wounded, Major Findlay continued his task, and after two unsuccessful efforts, owing to his men being swept down, he eventually placed the bridge in position across the lock, and was the first man across, subsequently remaining at this post of danger till further work was completed.

"His cool and gallant behaviour inspired volunteers from different units at a critical time when men became casualties almost as soon as they joined him in the fire-swept zone, and it was due to Major Findlay's gallantry and devotion to duty that this most important crossing was effected."

COLONEL J. M. LAMBERT, OBE

JEFFREY MAURICE (JEFF) LAMBERT died at his home in Minster-in-Thanet, Kent, on 19 June 1967, aged 67 years, after a long illness steadfastly borne. With his death the Corps has lost an officer skilled in many fields and one well versed in the history and traditions of the Sappers, who could, in a few well-chosen sentences, paint a vivid word-picture of some of the most glorious moments in their long story from Norman times to the present day.

Commissioned into the Corps in October 1920, he went to India, after his Young Officer training at Chatham, where over a period of five years he served with the Royal Bombay Sappers and Miners and in Military Works appointments.

Returning to the home establishment in 1928, he was posted to M Company of the Depot Battalion RE at Chatham, where he was in charge of the Buglers and Trades Boys, a splendid collection of youths who in the course of time were to match up to the challenge of war and to rise to officer rank of command and technical responsibilities, and who under Jeff Lambert's inspiration, as boys, gained outstanding successes both in games and sports and scholastically.

From Chatham he was posted to Egypt in October 1929. He served there for five years in the 42nd Field Company RE and as DCRE, Cairo, an advent to his wartime exploits with the 8th Army in the Western Desert.

From July 1935 until April 1939 he served at Aldershot as Adjutant RE Troops. They were the sunset years of the Aldershot "Mounted Sappers". A great horseman, and a splendid figure on a horse, he hunted regularly with the South Berks and Vine Foxhounds during the seasons 1935-6 and 1936-7, and during the 1937-8 season when war clouds were menacing and the future of foxhunting seemed to be uncertain, if not doomed, he went farther afield for a last fling to the grass of Leicestershire to hunt with the Belvoir. On his famous horse "Benjimin", named after Mr John Jorrock's boy who was so "uncommonly fond of marmilade", he was one of the Royal Engineers Jumping Team that at the 1938 Aldershot Horse Show won the Mounted Units Challenge Cup, open to the Army. It was a glorious swan song before mechanization and ended truimphantly a long series of equestrian successes over the Cavalry and the Gunners of Aldershot Command.

From Aldershot he was posted to command the 1st Fortress Company in Gibraltar, where he was able for a brief period to share with generations of Sapper officers who had served on the Rock the delights of hunting with the Royal Calpé Hunt before war broke out in September 1939. Hitler's war brought to an end that famous Hunt with which two reigning monarchs had once hunted and, despite its ups and downs, could trace an unbroken descent from the pack of foxhounds brought out by Wellington to Portugal to divert himself and his officers safely at ease behind Fletcher's impregnable Lines of Torres Vedras.

His war service was spent chiefly with the Eighth Army in the Western Desert. He was CRE 44th Division at the Battle of Alam Halfa, where one of his Sappers (Sapper D. Stansfield) received an immediate award of the DCM for having, by himself and in broad daylight and under close-range enemy tank fire, laid and armed mines to close the gap in the protective minefield at Queen's Gate, the rest of the "gate picquet" having been either killed or wounded. He was also CRE of the Division at the Battle of El Alamein. In recognition of his own gallant and distinguished service in the Eighth Army operations he was awarded the OBE. He was a great desert warrior and it was not unnatural that he was later selected as Commandant of the Middle East School of Military Engineering at Gebel Maryam on the banks of the Suez Canal. There were many British and Commonwealth soldiers in Egypt and Palestine in those days. The Sapper units made full use of the MELF SME and the Pioneer Platoons of all the numerous Infantry Battalions attended a

series of excellent field engineering courses laid on for them by Jeff Lambert and his staff.

From Egypt he was posted to a CRE (Works) appointment in Palestine and was involved in the run-down and final evacuation of British troops from the Holy Land, leaving it to the warring Arab and Jew.

Invalided home, his last posting was to Chatham, where he commanded one of the Regiments (later designated 12 SME Regiment) and was President of the HQ Officers' Mess Committee. He retired on 15 April 1952.

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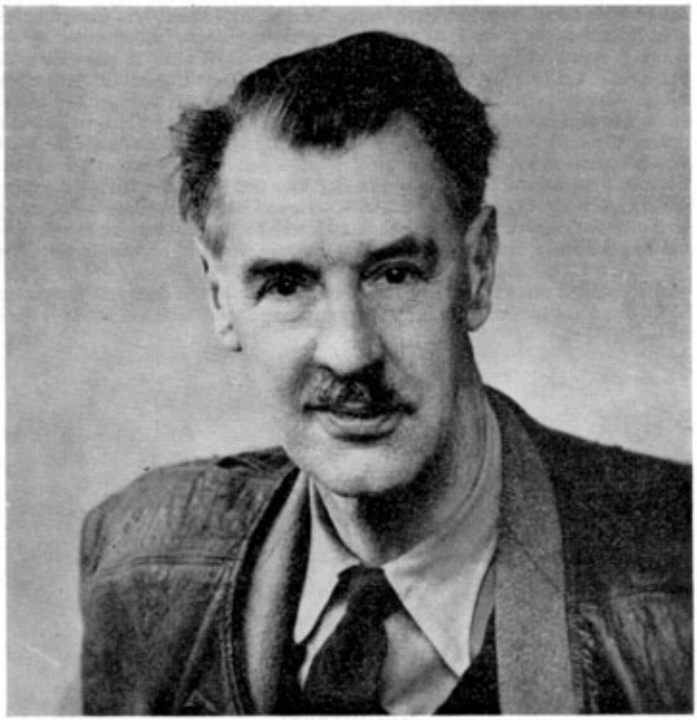

Colonel J. M. Lambert, OBE

After his retirement he was employed as an author of RE training publications and he served for many years as a valued member of the Institution's Publications and Library Committee until failing health forced him to give up these activities. He was a frequent contributor to *The Sapper* and the *RE Journal*. The November 1951 issue of *The Sapper* contained a splendid story of Sapper Stansfield's heroic action at Queen's Gate and his immediate award of the DCM, a much-coveted and rarely given decoration, the first to be won by the 44th Division in the Western

Colonel J M Lambert OBE

Desert campaign. His contributions to the *RE Journal* included articles on the reflections of a Regimental Officer on the promotion of NCOs, on Soldiers' Schools, on mine warfare in the Western Desert, on the RE tasks during the Battle of El Alamein, and a most excellent article on the history of the RE HQ Officers' Mess, reprints of which are given to all newly commissioned Sapper officers when joining at Chatham. His most outstanding literary achievement, however, was the publication *The Portraits and Silver of the RE HQ Mess*, undertaken on behalf of the Council of the Institution of Royal Engineers in 1963, and it was typical of him to donate to Corps charities the honorarium voted him by the Council for his work.

C.M.M. in a letter of tribute to Jeff Lambert recalled how popular he was at Aldershot in the 30's. It was, however, during his final Chatham posting that he got to know him best. Brigadier, later Major-General, Basil Davey was Commandant and determined to bring back as many traditional customs and previous splendours as quickly as possible to the Headquarters Mess after its war-time exile at Ripon. In Jeff Lambert he had an ideal PMC, and in Lieut-Colonel Jim Chatterton a Mess Secretary dedicated to running the Mess in an orderly fashion. The triumvirate was a remarkable one. It was, however, Jeff Lambert who kept the balance and he had a very real understanding of the Young Officers whose home the Mess was and their need occasionally to blow off steam. He had recently read Jeff Lambert's *Portraits and Silver of the RE HQ Mess* and was fascinated by it; writing good English was one of Jeff's great talents. He had last April written to Jeff to say how much he enjoyed reading the book and received a most touching reply which must have been dictated to his wife, for the only words in his own handwriting were "Dear Clive" and "Yours ever Jeff".

Jeff Lambert was a quiet, level-headed person, very lovable and greatly respected by all who knew him, and our deepest sympathies go to his wife and family in their loss.

Book Reviews

GUGGISBERG

R. E. WRAITH

(Published by the Oxford University Press. Price 42*s*)

Mr Wraith, who has had wide personal experience of West Africa and her people, has written a most fascinating book on that remarkable Sapper officer Brigadier-General Sir Frederick Gordon Guggisberg, KCMG, DSO who, like many other officers of the Corps, achieved success not only in their own profession of Arms but also in the field of Colonial administration. It is about Guggisberg in this latter capacity that the book almost exclusively deals.

Born in Canada, Guggisberg was educated in England and passed into the RMA, Woolwich in 1887 from where he was commissioned into the Royal Engineers. He was a great cricketer representing the Shop and later he captained the Corps side in representative

matches. He also played for the MCC and the Free Foresters. He played soccer for the Casuals for several seasons and he also played rackets, golf and polo with skill. His first overseas posting was to a Submarine Mining Company in Singapore after which he was appointed Instructor in Fortifications at the RMA, Woolwich where he spent four years during which time he wrote a *History of the Shop* and a volume entitled *Modern Warfare* and revolutionized the methods of field engineering training carried out at the Academy.

In the autumn of 1902 he started his career on the West Coast of Africa with which his name will always be associated and where he was to spend eighteen out of the remaining twenty-seven years of his life. He was first employed on survey duty in the Gold Coast Colony. There were practically no maps in existence and the pioneer work he did and directed was of the greatest value. He became Director of Surveys in 1905, and in 1908 his efforts were recognized by the award of a CMG. In 1910 he was appointed Director of Surveys in Southern Nigeria where he was faced with similar problems to be overcome, a challenge that he eagerly accepted. On the amalgmation of Southern and Northern Nigeria in 1913 he became Surveyor-General of Nigeria. During this period he wrote for the instruction of his assistants a *Handbook of the Southern Nigeria Survey* which clearly defined the duties of all members of his staff and their relations with the Civil Administration, the training and education of Africans as surveyors and complete technical instructions as to details and methods to be employed in the field. Sir Charles Close, CMG, one time Director-General of the Ordnance Survey, wrote that they were model instructions, and the Survey of Southern Nigeria a model survey.

Recalled for military service in 1914, he was given command of a Kitchener Army Field Company which he took to France in 1915. He was soon appointed CRE of the 8th Division and commanded the divisional sappers during the battle of the Somme. He later became CRE 66th Division until being given command of an infantry brigade. He later became Assistant Director of Training in France.

He retired from the Army with the rank of Brigadier-General in 1919 on being appointed by the Colonial Office as Governor of the Gold Coast Colony. He was fortunate in that on taking up the appointment the finances of the Colony were booming and considerable sums of money were available to finance his schemes for development. His eight years as Governor produced a spectacular advance in the Colony and he is remembered today by many people of Ghana as one of the most enlightened Governors of Colonial days. The chief planks of his programme were the education of the African and the general improvement of their standard of living by developing to the full the commercial wealth of the Colony which was based mainly on the export of cocoa. Achitoma College, which he founded, was to become one of the largest and most complete educational establishments in Africa. The Korle Bu Hospital at Accra was built under his direction. During his time as Governor the Colony's railway mileage was doubled, Accra and Kumasi were linked by a new central railway and surveys of every possible railway extension were undertaken. To increase the export of cocoa a deep water port was needed to enable ocean-going ships to tie up alongside instead of having to rely on the slow and often perilous surf boats which then provided the only link with the shore. Guggisberg selected a site for the harbour at Takoradi and it was due to his drive and energy that, in spite of immense technical difficulties and almost disasters, the new harbour was officially opened in April 1928, a year after the end of his Governorship.

Knighted for his eight years work as Governor of the Gold Coast he remained unemployed for almost two years before being appointed to Governorship of British Guiana in August 1928. Here he found the Colony's finances in grave straights and he at once introduced schemes to effect all possible economies in the cost of administration. He was, however, a sick man and the immense amount of work he took on his own shoulders broke him down. In July 1929 he was forced to return home with all his schemes for reform just begun. He died on 21 April 1930 in his sixty-first year.

What manner of person was this tall, handsome, athletic and aristocratic-looking man? He was twice married. As a young officer in Singapore he eloped with the seventeen-year-old daughter of his Commanding Officer by whom he had two daughters. The marriage however did not last and his wife left him and the two girls for a Church of England clergyman. He married secondly, when on home leave from the Gold Coast in 1905, a Miss Decima Moore, a musical comedy actress and concert singer who had appeared in many of the Gilbert and Sullivan operas and who had sung at some of London's principal concerts at the Albert Hall.

In 1909 Guggisberg and his wife published a book, *We Two in West Africa*, which told of their life in the Accra Cantonment and on their many journeys in the bush. In a number of places she was the first white woman the local people had ever seen. Even in Kumasi she was only the third. During the 1914–18 War she ran a Leave Club for the Forces in Paris,

and after the Armistice she set up a British Empire Leave Club in Cologne for the Army of the Rhine. She was created CBE and it was largely due to her influence that Lord Milner, Secretary of State for the Colonies, selected Brigadier-General Guggisberg as Governor of the Gold Coast. Lady Guggisberg died in 1964 in her ninety-fourth year.

As Governor of the Gold Coast Guggisberg believed in the establishment of indirect rule through the paramount chiefs; like others of his generation he misjudged the nascent nationalist movement. He could not have foreseen that one day independent African countries might be ruled by "Failed BAs" or the alumni of Sandhurst. Although by nature a Conservative and Traditionalist his policies were often considered too advanced by the Colonial Office and by the Coasters. He knew every one of his European staff personally, not only their names but generally their nicknames and all about them. There is an Apocryphal story concerning him that once, when writing to the Colonial Office about possible replacements on his staff, he requested the inclusion of a good slow left arm bowler. His great virtue lay in his fantastic capacity for work, his drive and determination and his faith in the destiny of the African people and his unremitting toil in their service.

His last years were saddened by illness and financial anxieties. He died obscurely and alone in a sea-side boarding house, and it was left to his Gold Coast friends to erect a simple headstone over his bare, untended grave bearing the inscription:

"*To the everlasting memory of Governor Sir Gordon Guggisberg who died in 1930 at Bexhill, this Memorial was erected by the Paramount Chiefs and the people of the Gold Coast and Ashanti.*"

THE UNENDING VIGIL

PHILIP LONGWORTH

(Published by Constable, London. Price 42*s* net)

This history of the Commonwealth (formerly Imperial) War Graves Commission 1917–67 is dedicated to the one million six hundred and ninety five thousand men and women of the Imperial Forces who gave their lives in the two World Wars 1914–18 and 1939–45, and is published to mark the occasion of the semi-centenary of the Commission and the fifty years of its unceasing vigilance to ensure that the names of those who gave their lives in battle in the two World Wars shall live for evermore.

The Commission's work had its origin in a small civilian Mobile Red Cross unit, formed in 1914 to search for wounded and missing during the retreat of the British Expeditionary Force from Mons. Later soldiers from many parts of the Empire came to fight in France and Belgium and on other fronts, and by a Royal Charter, dated 21 May 1917, a Commission, representative of all parts of the Empire, was established to take over the care of the graves.

The Commission adopted, and has steadfastly maintained, two important principles. Firstly that there should be no distinction on account of rank, religion or race; thus the dead are honoured by name in a manner reflecting their equal sacrifice and each has an individual memorial either in the form of a headstone to mark his grave or his name is inscribed on a composite memorial to the missing who have no known resting-place. Secondly, the dead should be commemorated in perpetuity, thus the cemeteries and memorials, designed and landscaped by the most eminent architects, are constructed of the most durable materials; workmanship and horticulture has been of the highest order and the sites have been protected in every possible way. The beautiful and dignified war cemeteries and memorials in far-flung foreign fields have brought comfort to generations of bereaved relatives and are a lasting tribute not only to those who gave their lives but also to the dedicated efforts of the Commission and the many Sapper officers who have worked for it.

Philip Longworth's book describes the political, constitutional, administrative, financial, social, aesthetic and technical problems the Commission had to face and the difficulties caused by the Second World War, when access to some of their cemeteries was temporarily impossible.

It is a moving and excellently written book, worthy of the high standards of the Commission whose history it relates.

LIGHT RAILWAYS OF THE FIRST WORLD WAR

W. J. K. DAVIES, BA, AKC

(Published by David and Charles, Newton Abbot. Price 35*s* net)

The arrival of this publication is particularly opportune and appropriate, coinciding as it does with that of several recent books on specific operations of World War I, in which light railways played a most important part, and with the transfer of responsibility for this form of transport to the Royal Corps Transport. The author merits our thanks for providing this valuable record at this time, and for all the work and research involved in its compilation. For the present generation in particular it seems to emphasize the fundamental importance of vision, initiative and adaptability. The book is well produced, well documented and amply provided with sketch maps, illustrations and data.

C.A.B.

THE ESSENTIALS OF THE THEORY OF STRUCTURES

MAJOR J. H. JOINER, BSc, RE, AMICE, AMIStructE

(Published by Crosby Lockwood & Sons Ltd, 26 Old Brompton Road, London, SW7. Price 30*s*)

It has become rare indeed for a serving RE officer to publish a textbook on a professional engineering subject. Major Joiner is an outstanding exception and his recently published textbook *The Essentials of the Theory of Structures* will satisfy a long-standing need for both practising graduate engineers and students. The author has earned the reputation of being one of the best structural engineers in the Corps and of possessing the rare knack of being able to present complex subject-matter in a simple way so that it can be understood and put into practice. It is, therefore, not surprising that his book is written in clear, simple English, that the sequence and layout is logical, and that it demonstrates the author's complete mastery of his subject.

Major Joiner's aims were to fulfil two needs not usually met in existing treatises. First to cover the subject of Theory of Structures up to approximately Degree or HNC standard, so that the engineering student can understand and apply the various principles involved without the complication of having to go too deeply into theoretical aspects. Second to provide a textbook that the qualified engineer can consult from time to time to refresh his memory on basic formulae, methods and principles of analysis without having to wade through theoretical derivations which are unnecessary for his purpose. These aims have been completely achieved.

The author was an Instructor in the Civil Engineering School of the Royal School of Military Engineering from 1958 to 1960 and during his tour he wrote a RSME training publication *Notes on Theory of Structures* which was then, and with revision is still, used as the basis for instruction in this subject on Long Civil Engineering Courses. Those who have used these Notes will realize how valuable Major Joiner's new book will be to the practising civil engineer. The sign conventions and symbols used are the same as those taught at the RSME, so this is an ideal book for use by professionally trained RE officers. The fact that it is written in concise military style and is interesting to read is an added advantage to the military engineer.

The text is very well illustrated with exceptionally clear diagrams and each section includes examples showing the application of the subject-matter to practical design. The book includes sufficient soil mechanics to enable the reader to design retaining walls and foundations. The treatment of reinforced concrete has been deliberately restricted to the design of simple beams, as the author correctly considers that there are many separate textbooks on this subject, and present design methods may become out of date with the publication of a new Code of Practice (CP 114). Throughout the book emphasis is on design to British Standard Codes of Practice and British Standard Specifications; it thus has a very practical approach to design. The subject-matter includes the analysis of frameworks (including space frames), shear force and shear stress, the bending of beams, beam deflection, travelling loads, compound stresses, struts and columns, and the design of dams, retaining walls and foundations. The various methods of analysing statically indeterminate structures are fully covered and there are sections on arches, suspension cables and bridges and the plastic design of beams. Very useful appendices are included giving a complete summary of formula, design stresses and values of shear force, bending moments, deflection and fixed end moments for beams under various conditions of loading.

R.C.G.

ELECTRONS, NEUTRONS AND PROTONS IN ENGINEERING

J. R. EATON

Professor of Electrical and Nuclear Engineering Purdue University, Indiana

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price £5 5*s* net)

This book is very advanced, and is written for the practical engineer with an inquisitive mind. The reader of the book should have a broad knowledge of classical physics and of differential and integral calculus, and although based on all branches of modern physics, the subject-matter is presented from the viewpoint of the engineer rather than the physicist.

The behaviour of small particles when grouped together as nuclei, atoms, crystals and gases may be used to explain the characteristics of engineering materials and processes, so that the book integrates aspects of two large areas of knowledge, namely modern physics and engineering. For instance, for many years the behaviour of small particles has been studied in connexion with electrical conduction through gases, from which has developed the vast production of electronic valves, neon tubes and fluorescent lamps. Other fields discussed include conductors, super conductors and semi-conductors; alloying of metals; nuclear radiation applied to transmutations of elements, biology and medicine and chemical processing; magnetic materials and dielectics; and the development of corrosion-resistant materials.

Chapter 2 deals with the microscopic domain, which is a region composed principally of empty space and no material bodies, but filled with force fields holding minute particles both together and apart, and consequently can influence such properties as mass, energy, distance, force, fields and charge.

In Chapter 3 basic relations between force and energy, magnetic fields, gravitational fields and electromagnetic waves are discussed in a clear and meaningful way.

Chapter 4 deals with the atomic nucleus and introduces, among other things, the various laws of radioactivity. From this chapter the reader is led into the structure of the atom (Chapter 5); physical and chemical properties of atoms (Chapter 6); structure of gases (Chapter 7); binding forces and energy (Chapter 8).

After this extensive introduction to the atomic characteristics of matter, Chapters 9 to 12 cover the structure of solids and surfaces, and consider various aspects of engineering, such as alloying, heat treatment pressure processing, painting, plating, corrosion, friction, lubrication, conduction of electricity between contacts and electron emission. Semi conductors are also introduced here, and again extensively covered in Chapters 17 and 18.

Electrical conduction through gases is dealt with in Chapter 15, and the theoretical introduction is followed by arc discharge and corona, electronic valves, photo-cells, nuclear radiation counters, mercury arc rectifiers and circuit breakers.

Dielectrics and magnetic materials are discussed at some length in Chapters 19 and 20. Magnetic materials find application in transformers, generators, relays, loudspeakers and electrical instruments, and account for 100 million dollars of magnetic steel per annum in the USA alone.

The last 130 pages of the book (out of a total of approximately 540 pages) deal entirely with nuclear fission, and could easily be a complete book in themselves. Basic physics, nuclear reactors, radiation measurement, radiation damage, and radiation applications in industry and science are covered in considerable detail. It includes a coloured chart of the nuclides which, alas, is spoilt by minute print too small to read.

I have only one complaint of consequence, namely: that every chapter ends with questions, largely of a mathematical nature, but the book does not include answers. This leaves the impression that the author does not know the answers himself, or else the reader cannot be trusted to answer the questions without sneaking a look at the answers first.

This book is very soundly written, and improves with each reading of the text. As a reference book, or indeed as a textbook, it is excellent and is written in a much more understanding manner than many physics books upon which some of this text is based. The dividing line between physics and engineering is largely determined by professional interest.

D.R.T.

THE ORDNANCE SURVEY ANNUAL REPORT 1965–66

(Published by HMSO. Price 7*s* 6*d* net)

This report, which is supported by a number of appendices and plates, describes the progress made in the task of remapping Great Britain. It also includes brief accounts of the various technical and scientific activities within the Ordnance Survey.

It will be seen that the 1/1250 scale survey of the major towns is 90 per cent complete and that the programme of revision of the old county 1/2500 scale plans is progressing steadily, although there is still a long way to go. With the object of speeding up the programme, Government approval was given in February 1966 for an increase in the staff of the Ordnance Survey by 20 per cent spread over the next ten years, and this, coupled with greater use of air photography, will enable the whole task of restoring the up-to-dateness of the Survey to be completed by 1980.

During the year a start was made on the publication of a new series of 2½ in to the mile maps. A new 1 in to the mile tourist map of Cambridge was published in addition to a number of revised sheets of the standard 1 in series. A revised edition of the archaeological map "Britain in the Dark Ages" was also published.

The Report mentions the continued co-operation between the Ordnance Survey and the Royal Radar Establishment on satellite triangulation, a subject where there is considerable international activity. Other experimental work includes the use of colour photography, the replacement of glass by plastic drawing materials and the production of large-scale plans from microfilm.

The Report records that the foundation stone of the new Headquarters Office at Southampton was laid by the Minister of Agriculture, Fisheries and Food (the Rt Hon Frederick Peart, MP) on 26 April 1965.

D.L.G.

ANALYSIS OF ENGINEERING CYCLES

R. W. HAYWOOD, MA, BSc, Wh Sch, AMIMechE

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

This book is included in the Thermodynamics and Fluid Mechanics Division of the Commonwealth and International Library of Pergamon Press.

The author, a Fellow and Director of Studies in Mechanical Sciences, Fitzwilliam College, and Lecturer in Engineering at the University of Cambridge, has confined his text to the theory of the overall performance, under design conditions, of work-producing plants. There are no descriptions of the construction of the different plants he has considered—in fact, he assumes "that the reader already has a knowledge of the hardware".

The text is divided into two parts. Part I deals with the principles of simple steam, closed-circuit gas turbine, internal-combustion and refrigeration-plant cycles, and illustrates their similarities and differences. Part II studies the more complex cycles of plants using:—advanced gas-turbines, steam-turbines, nuclear power (gas and liquid-cooled reactors), combined gas and steam plant, binary plant (where a "topping" cycle is superimposed directly on another cycle), and finishes with a chapter on advanced refrigeration and gas-liquefaction plant which explains the Linde, Claude and Heylandt liquefaction processes, their operational requirements, and the modifications that give higher performance.

The text, which is only suitable for undergraduates, is purely analytic and defines "performance criteria"—which the author insists is the only real yardstick by which a true engineer can judge performance.

Each chapter is provided with a number of student problems which have stemmed from the author's experience gained whilst lecturing to Cambridge undergraduates at all levels.

F.T.S.

ELEMENTS OF ENERGY CONVERSION

CHARLES R. RUSSELL

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 60s)

During the past ten years considerable thought has been devoted to the study and development of energy-conversion machines and equipment in order to meet the multitude of practical and environmental requirements demanded by the new fields of scientific and engineering endeavour. This has resulted in many inventions which have extended the range of energy-conversion machines from the original steam and internal-combustion engines to the latest radioisotope power sources.

Information on the modern, sometimes specialized, applications is difficult to get unless students and others are blessed with the facility of a reference library which is provided with a wide range of technical journals and Government research publications.

To offset this the author has included in the 400 pages of his text the theory, construction and operation of most of the modern energy-conversion machines and devices which depend for their operation on chemical energy, electro-chemical processes, solar energy, thermo-electricity and radioisotope power sources. In addition, he has covered the theory of the various forms of energy, thermal properties and relations and the principles of heat engines.

In all the text provides undergraduates with an excellent introduction to the theory of fundamental thermodynamics as applicable to the old and new forms of energy conversion.

Included are a number of photographs, diagrams, tables and charts in support of the text.

The book is excellently printed, well bound, and should whet the appetite of readers for modern information.

F.T.S.

BASIC FLUID MECHANICS

S. J. PEERLESS,
of the University of London

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

The information contained in the 550 pages of this well-bound book is based on a series of lecture notes written by the author and distributed to second-year students of the Department of Mechanical Engineering, Imperial College of Technology, at South Kensington, and extended to contain considerably more material than that required for a normal one-year undergraduate course of forty lecture hours.

The principal aim of the author has been to explain, with mathematics of simple integration level and the associated laws of hydraulics and thermodynamics, those forces occurring in moving fluids—both liquids and gases—applicable to practical mechanical engineering. In fact, the author stresses the necessity of noting the affinity between fluid mechanics, rigid-body mechanics and thermodynamics, which is uncommon in most textbooks.

After a short introduction to the subject, the text deals successively with: Similarity of Physical Phenomena (geometric, kinetic and dynamic); Dimensional Analysis (units, force and mass, physical equations and dimensions); Analytical Models of Real Flows; Control-Volume Analysis; Steady One-Dimensional Reversible Flow; Two-Dimensional Constant-Density Laminar and Turbulent Flows; Elementary and Further Analysis of Turbomachines; Hydraulic Power Transmission; and a description of further advanced developments of fluid mechanics.

Three appendices are provided covering notation, consistent unit names and fluid properties, and each chapter is provided with problems for student use, photographs, diagrams and charts.

F.T.S.

ENGINEERING DRAWING AND CONSTRUCTION VOLUME TWO

L. C. MOTT,
Lecturer at Farnborough Technical College

(Published by Oxford University Press, Ely House, London W1. Price 25*s*)

The first of the two volumes, which was reviewed in the March 1966 edition of the *RE Journal*, covered the principles of plane and simple geometry and machine drawing applicable to the General Engineering Course and the first two years of the Mechanical Engineering Technician's Course.

This volume takes the student farther ahead through the remainder of the syllabuses up to the examinations for the Mechanical Technicians' and Ordinary National Certificates, and also gives a good coverage of the GCE "A" level syllabus.

With a large selection of drawing exercises, for which the diagrams are adjacent to the relevant descriptive text and copy instructions, the author deals firstly with plane and solid geometry and covers the projections and traces of lines and planes, auxiliary and isometric projection, the intersections and developments of surfaces and the construction of cams. This is followed by the engineering drawing section, laid out in a similar manner, covering metric screw threads and fasteners, gearing and gear construction, the function and application of dimensioning and tolerancing, gauges and gauge tolerances, press tools, jigs and fixtures.

The exercise drawings and the descriptive texts balance each other page for page, so the student can easily reconcile his copy drawing with the original at each stage of his work.

The text also gives the definitions and the terms used for a variety of machine parts, and explains the purpose for which the part is used in an assembly.

F.T.S.

GRAPHICAL SIMULATION

FORREST WOODWORTH
Assistant Professor of Engineering Design and Simulation, University of Detroit

(Published by International Textbook Company, Scranton, Pennsylvania.
Price $9 (nine dollars))

This textbook is the most comprehensive work the reviewer has seen on the associated subjects of engineering drawing, geometry, the solution of mathematical problems, and the graphical work attendant upon modern digital processing.

The information presented is divided into three main parts, namely communication, analysis and supplementation.

The section on graphical communication deals with the usual styles of representation used in engineering drawing and covers the principles of projection, orthographic drawing, pictorial approximation, dimensions, the specification and processing of drawings, standard items and conventional symbols. This section is supplemented by nine appendices dealing specifically with drawing equipment and its use, lines and their use, typical geometrical constructions, charts, dimensioning practices, section views, conventional practices, and screw threads.

The representation of abstract principles, as detailed in the graphical analysis section, covers spatial and vector geometry, orthogonal analytic geometry, functional co-ordinates, empirical functions, algebraic geometry, fundamentals of graphical calculus and the graphical methods used to solve differential equations.

The graphical supplementation section, dealing with the representations employed as by-products of mechanization and automation in design work, covers electrographic analogues, including the analogue computer, its auxiliaries and programming; digital computer processing and associated graphical work; computer languages; and computer-aided graphical analysis.

A final chapter, entitled Extensions of Graphical Concepts, shows the way ahead and the possible fields into which graphical simulation may be of service to technologists.

The information presented caters for beginners through to professional draughtsmen, and those interested in finding solutions to problems in the mathematical and technological fields. The book is excellently produced, well illustrated and undoubtedly one of the most worthwhile publications of its kind available today.

F.T.S.

Technical Notes

CIVIL ENGINEERING

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

ELEVATED ROADS FEATURE. The February 1967 edition features a series of articles on elevated roads and so is of more than usual interest to Sapper officers, who are generally more concerned with "horizontal" engineering (roads and airfield construction) than structural civil engineering works. The nine articles which make up this feature are reviewed below.

DEMOUNTABLE FLYOVER DESIGN. Details of the competition for the design of this temporary flyover at Barking were given in the *RE Journal* Technical Notes for March 1967. The winning design, by Messrs. Braithwaite and Co (Structural) Ltd, was constructed in January 1967, in the commendably short time of only eight days, on prepared foundations. The ground conditions on site required the use of large-diameter piles for the foundations. The deck spans are carried on transverse portal frame trestles pinned in each direction at the base. The deck spans are prefabricated to single lane width with a span length of 36 ft. They are of steel and concrete construction acting compositely.

KINGSTON BY-PASS FLYOVERS AT SHANNON CORNER. The second article in the elevated roads feature describes the scheme, which is now nearing completion, for the construction of two flyovers at Shannon Corner on the Kingston by-pass in Surrey. The scheme was prepared by Surrey County Council as agent authority for the Ministry of Transport. W. & C. French Ltd have nearly completed the construction work, which they started in February 1967 at a contract price of about £1,500,000.

PREFLEX IN FLYOVER CONSTRUCTION. This article, by Rhys J. Nicholas, AMICE, MInstHE, sets out to show the advantages which can be gained from using Preflex beams in flyover construction. It suggests that the use of this type of construction can affect the economics of the project as a whole and provide a solution to many difficult site problems.

The Preflex beam makes use of a steel section of high-yield steel, which is preloaded to a degree and in such a way that the stressses in the steel exceed the stresses that will be met in the working life of the beam. This preloading is carried out twice—the first time to stress relieve the beam within its working range and the second time the stress is maintained while a concrete casing is cast round the tension flange and allowed to cure. On release of the preload the steel beam tries to recover, but is effectively restrained by the concrete, which takes up a precompression. Thus a type of composite prestressed beam is formed. The author illustrates his article with details of recent examples of the use of this technique.

TINSLEY VIADUCT. F. N. Dinsdale, BSc, who is an agent for the Cleveland Bridge and Engineering Co Ltd, describes the construction of Tinsley viaduct, which carries the M1 across the Don Valley, between Rotherham and Sheffield. It is a novel two-level design which carries the motorway on the upper deck and 24 ft dual carriageways joining the local road systems on the lower deck. This viaduct is constructed principally in structural steel.

MINI-MOTORWAYS. This article, by F. R. Shaw, BSc, AMICE, FGS, discusses some current ideas for solving traffic problems in urban areas. It suggests the segregating of light from heavy traffic and spending the limited resources available on the construction of light-weight, very-low-cost new roads in such a way as to relieve traffic congestion in towns at minimum cost.

SCAFFOLDING IN ELEVATED ROAD CONSTRUCTION. With the increasing need for elevated motorways, a non-sophisticated approach to the problem of providing the necessary shoring equipment is required. In this article, J. A. F. Crawford, BSc, AMICE, ACGI, describes briefly the development of the various methods and systems currently in use.

LOFTHOUSE INTERCHANGE IN YORKSHIRE. This article by W. R. Varley, BSc, AMICE AMIHE, describes the factors and design problems associated with the design of this interchange between the Sheffield-Leeds motorway (M1) and the Lancashire-Yorkshire motorway (M62).

STEELWORK IN ELEVATED HIGHWAYS AND FLYOVERS. This article is by G. Bernard Godfrey, AMICE, MIStructE, who is Technical Director of the British Constructional Steelwork Association. The principal object of this article is to describe some of the elevated highways and flyovers which have been constructed in structural steel.

SOME RECENT AND CURRENT PROJECTS. The last article in the elevated roads feature described some recent and current projects. Of the six projects described, three are of particular interest, as serving RE officers have been attached to the contracting firms during the construction. Major R. D. Holland, BSc, RE, is at present working as an executive engineer with John Laing Construction Ltd on the Western Avenue Extension, which, when constructed, will be the largest elevated road in Europe. Captain J. T. Stokes, RE, was attached as a section engineer to Leonard Fairclough Ltd, who were the main contractors for the construction of Manchester's Mancunian Way elevated highway. Major T. J. Knott, BA, RE, was attached to W. & C. French Ltd on the construction of the Bow Bridge Intersection and was employed by them as section engineer in charge of the construction of the main flyover on the A11.

NEW LIFEBOAT STATION AT TREVOSE HEAD IN CORNWALL. M. G. Barrett, BSc, AMICE, has contributed a short article on the construction of a new lifeboat station with launching slipway in Cornwall.

INSTANT AIRFIELDS. Two photographs are shown in this edition of the use of a new material recently developed in the USA for constructing "instant" airfields. The object was to find a material which, when sprayed on bare earth, hardens to produce a surface strong enough to support a 10-ton aircraft.

The final solution was a modified chlorinated polyester resin with fibreglass reinforcement and temperature-resistant additives. The material hardens quickly and apparently proved successful. This principle obviously has a possible military application for helicopter and VTOL landing pads.

WATER HAMMER IN SMALL-BORE MAINS. Experimental investigations into the cause of water hammer in small-bore mains has been carried out by B. C. Pagdin, MEng, Dip tech, and E. J. Sarginson, MEng, PhD, AMICE. The first part of a report on their work and analysis is included in this edition.

R.C.G.

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

H-SECTION STEEL PILING. In an article by T. Gilmour, BSc, AMICE, of Messrs Dorman Long (Steel) Limited, the merits of H-section steel piles are discussed in relation to other forms of piling. The author justifiably extols the virtues of the H-section pile and, perhaps, gives the impression that it is the universal answer. This form of pile is cetrainly worthy of consideration and site tests may well show it to be the most suitable for specific projects. As a friction pile it provides a large peripheral-area/weight ratio, it is easy to handle and drive, and extension is a simple welding task, which is an attractive attribute when working with restricted headroom.

DEVELOPMENT OF SCOTTISH ISLAND AIRPORTS. MPBW have recently undertaken projects to strengthen and extend the runways at Islay, Kirkwall and Sumburgh, to accept the Viscount 800 aircraft (LCN 30). The work was carried out on behalf of the Board of Trade. The article describes briefly the work and organization at each airfield. Perhaps the most interesting feature of the design achieves economy in construction costs; the areas at the runway ends have been constructed to LCN 30 for the full 150 ft width, while the remainder of the runway is to LCN 30 only in the central 75 ft, the outer lanes being LCN 15. Construction to limits such as this imposes the necessary limitation upon operators that turning can only take place at the runway ends; the strength in the outer lanes is, of course, sufficient for occasional running-off.

R.C. SINGLE-BAY PORTAL FRAMES. In an article dealing with the inelastic behaviour of reinforced concrete single-bay portal frames Professor C. B. Wilby, BSc, PhD, MICE, MIStructE, discusses the theoretical treatment and a series of experimental results. He shows that the ultimate load at collapse is the same for frames with pinned and fixed feet, thus substantiating his hypothesis of a local collapse mechanism rather than the classical collapse mechanism for the whole frame.

Varying proportions of reinforcement in the rotating-large-sections of the frame are discussed.

COMPACTION MACHINERY TESTING EQUIPMENT. By locating radioactive sources and Geiger-counters in vertical tubes set in a soil compaction test bed it is possible to determine non-destructively the degree of compaction achieved at any depth and, if necessary, after each pass of the compaction equipment. An interesting article describes this new technique and the work of Fritz Fisher at the Scheid Maschinenfabrik at Limburg in Germany.

The author expects that the Construction Industry Training Centre at Bircham Newton will use a similar technique to assist in training compaction plant operators. It is stressed that the techniques of compaction on site are becoming more and more sophisticated and it is suggested that the vibrating roller and rubber-tyred machines may soon displace the traditional road-roller completely.

FILM-FACED PLYWOOD FOR CONCRETE FORMWORK. I. D. G. Lee, BSc(Eng), FIWSc, Managing Director of the Finnish Plywood Development Association, describes a new form of plywood intended for use in concrete formwork. Essentially, standard-sized plywood sheets are treated with a phenolic-resin impregnated film, the function of which is to eliminate grain imprinting on the finished concrete surface. The article describes the material fully and provides design charts. Reuse and costs, special forms, fixing and jointing, and care and maintenance are also discussed.

J.D.W.

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

The editorial notes of the April edition include brief details and a photograph of the model showing the proposed project for modernizing Chatham Dockyard. The Ministry of Public Building and Works is carrying out a £4 million project to enable the Dockyard to service and refit nuclear submarines. The Consulting Engineers to the Ministry are Messrs W. S. Atkins and Ptnrs and the main contractors are John Mowlem & Co. Ltd.

CRANE GIRDER; by C. P. Thompson, Grad 1 Struct.E. The first part of an interesting and comprehensive article of the design of crane rails, joints and fittings is included in this edition. The author, who is a designer for Redpath, Brown and Co. Ltd., structural engineers, is obviously very experienced in this subject and has illustrated the article with excellent photographs and drawings.

BASE HEAVE IN BRACED EXCAVATION IN SATURATED CLAYS by G. J. King, MSc(Eng), ACGI. Predicting the behaviour of saturated clays is an ever-present problem for the civil and military engineer alike. The accepted reference book on this subject is *Theoretical Soil Mechanics* by Terzaghi. The author of this article contends that Terzaghi's theoretical solution for base heave in braced excavations in saturated clays is incomplete. In this article he therefore offers a complete solution derived using a similar method of analysis and making the same basic assumptions. This solution is developed and presented graphically, in terms of non-dimensional parameters, thus facilitating the solution of particular problems. Excavation below ground water-levels is also considered.

COMPUTER ANALYSIS OF OPEN CHANNEL FLOW. Many problems in civil engineering hydraulics fall in a marginal classification which, although the calculations are laborious and time consuming, are considered inappropriate for computer analysis. This article by Alan A. Smith, BSc, ARCST, AMICE, MASCE, attempts to classify a number of problems of open channel flow which occur with sufficient frequency to justify, in his opinion, the preparation of a series of standard routines which may be used individually or jointly with one another. A brief outline of the theory underlying each problem is given, followed by a flow diagram. A basic knowledge of computer programming, such as that gained in RSME short computer courses, is necessary before the average reader could understand this article. Since the article was written, ALGOL procedures have, in fact, been written for the programmes described in this article.

A NOTE ON THE ACCURACY OF DISPLACEMENT MEASUREMENTS IN SOILS USING AN X-RAY METHOD. This is a very short article by J. R. F. Arthur, MA, PhD, and S. J. Shamash, BSc, AMICE, AMIStructE. It describes their findings with regard to the accuracy of this method as a result of experimental work they have carried out in the Department of Civil and Municipal Engineering, University College, London.

* * *

Three articles are included in this issue on the prevention of accidents in the Civil Engineering industry. Accidents in the construction industry have so many causes that they cannot be eliminated entirely. These articles—"Three Steps for Safety" by Lieut-Colonel T. McMillan, "Computer Retrieval of Industrial Injury Decisions" by C. Tapper, and "Accident Prevention Legislation and the Contractor" by N. J. Forrest, are aimed at understanding the causes of accidents in order that steps can be taken to stem the current increase.

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

DESIGN CHARTS FOR COMPOSITE BEAMS. This article, the first of two by Colin Davies MSc(Eng), AMICE, MIStructE, gives an easily followed method for the selection of suitable steel, concrete combinations in composite floor construction. Design selection charts are included for concrete slab thicknesses of between 5 in and 8 in used in combination with standard Universal Beam Sections of Mild Steel to BS 15, 1961. The charts are not applicable to HYS Steel to BS 968. The design procedure is tabulated using the ultimate load method with suitable checks of the realized elastic stresses under working load. The second article will appear in the June issue.

SPLIT CYLINDER TENSILE TESTS ON UNSTABILIZED AND STABILIZED P.F. ASHES OF LOW COMPRESSIVE STRENGTH. The tensile strength of concrete determined by the split-cylinder test has been investigated by a number of previous workers and compared with the compressive strength found from cylinder specimens. In both tests, specimens of 6 in dia and 12 in long were used and the concretes had compressive strengths ranging from about 1,500 lb/sq in to 12,000 lb/sq in. This article by Professor H. B. Sutherland, SM, MICE, MIStructE, FRSE, Cormack Professor of Civil Engineering at the University of Glasgow, and T. W. Finlay, BSc, MSc, AMICE, a lecturer at the same university, reports the results of similar tests on cylindrical specimens of pulverized fuel ash. The specimens tested were of 2 in dia and 4 in long over a range of compressive strengths from 0 to 1,000 lb/sq in. Four ashes of varying gradings without additives and the same four ashes with the addition of lime or cement as stabilizing agents were used in the tests. It was found that the split-cylinder tensile test gave consistent results on small cylinders of low compressive strength. In addition, it was found that the ratio of the split-cylinder tensile strength to the compressive strength for low compressive strength specimens was similar to that found by other investigators for medium and high strength concretes.

REPORT ON USE OF PF ASH AT ELMDON AIRPORT, BIRMINGHAM. A very interesting article describes the tests carried out on PFA to evaluate its suitability as a fill material for the subgrade material of a major airport. The possibility of frost heave was fully investigated and also the effect of stabilization with cement. The results showed the advantages of using PFA under these conditions and in consequence the extension of the runway was successfully completed in April 1967 using this material.

WATERPROOFING OF SUBSTRUCTURE OF MALAYSIAN AIRWAYS HQ BUILDING, SINGAPORE. Originally presented before a meeting of the Cement and Concrete Association of Malaysia, this very readable article outlines the possible methods of waterproofing a substructure before describing in some detail the method chosen. The most interesting part of the paper details the use of a cement grout membrane formed beneath the base of the substructure, believed to be the first instance in which this method has been incorporated at the construction stage.

CRANE GIRDERS. In the second part of his article which appears in this month's review C. P. Thompson gives two fully worked examples on the design of crane gantry girders. The first example gives calculations for a simply supported girder using elastic design methods, while the second example is for a semi-continuous girder designed using the Plastic Theory.

B.O.B.

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

BLACKFRIARS BRIDGEHEAD IMPROVEMENT SCHEME. A short article encompassing a wealth of detail describes the Blackfriars Bridgehead Improvement Scheme. The Scheme is designed to segregate north/south and east/west traffic by means of an underpass and to provide the start of a new route linking Victoria Embankment with Tower Bridge.

The article includes information on the construction of an extension to the Victoria Embankment, on elevated roadway, re-roofing the District Line Tunnel and the construction of a new mains subway.

HEAD PROTECTION ON CONSTRUCTION SITES. E. M. ELLIS, a Director of Ellis Research and Testing Laboratories Ltd., discusses the requirement for the use of industrial helmets on construction sites. He includes short comments upon the design requirement, the reaction of the human brain to severe impact, and helmet testing. He emphasises that impact injuries account ultimately for a large proportion of industrial injuries. The matter is not just one of reducing the number of fatalities but of reducing the incidence of injuries resulting in long hospitalisation or in permanent disability.

SEWAGE DISPOSAL AND PURIFICATION WORKS. A description is given of major extensions to two major works, one at Oldington and the other at Mill Hill. This is an interesting article with much detail and well illustrated.

DESIGN CHARTS FOR COMPOSITE BEAMS. Part 1 of this article by Colin Davies MSc (Eng), AMICE, MI Struct E appeared in the May issue. The second and final part is included in this issue; it includes design charts and a worked example of the design of a composite beam for an interior panel of a floor slab.

THE FALLACY OF PLANE STRAIN IN CONSOLIDATION. E. T. Hanrahan ME, PhD, AMICE describes research which he undertook at University College, Dublin, with a view to investigating the validity of Terzaghi's theory of one-dimensional consolidation, the basis upon which consolidation analysis are conduction. He worked upon wet peat and, for this material at least, he found that the horizontal plane cannot be assumed a principle plane. In fact he found that the principle plane rotated through 45 degrees. The conclusion is that, the distribution of variation in strain across the horizontal plane are associated with pure water pressure and, at greater degrees of loading with an increased stiffness of the soil. Since the one dimensional theory is fundamental to consolidation analysis the results of further research upon other materials could be of considerable importance in foundation engineering.

J.D.W.

THE MILITARY ENGINEER

MARCH-APRIL 1967

EMIGRANT TRAIL TO FREEWAY. INTERSTATE 80 OVER THE SIERRA, by Robert E. Biggs. This describes the construction of a modern four-lane freeway, 2,920 miles long, from San Francisco Bay to the Atlantic coast of New Jersey. Particular reference is made to the section crossing the Sierra Nevada and the problems posed by the snow zones. There are very good photographs and details of the construction of the roadway are given with an account of the influence on the design and layout of the need for snow clearance.

RECENT ARMY MOBILITY EQUIPMENT. At the Army Engineer Research and Development Laboratories at Fort Belvoir work continues in a number of fields relating to increased military mobility. Some of them are described in a series of short articles.

REPETITIVE EXPLOSIVE DEVICE, by O. Kinzer and D. Craft. This is a device to lesson the load on the bulldozer by releasing rapid repetitive explosions of compressed air and gasoline from the cutting blade into the soil, disintegrating and moving the soil to either side of the cut thus created. Details of the equipment and method of operation are given with illustrations.

SHIPBOARD PROJECTOR, by Philip Morrill. This is a piece of equipment which projects a full-scale coloured image of a chart from 105 mm microfilmed slides, and also provides storage for the slides in easily accessible card-file drawers. The method of use is described, with details of design.

ROUGH-TERRAIN FORKLIFT TRUCK. These air or rail transportable trucks can unload landing craft grounded in the surf, and move supplies rapidly and efficiently even over sandy beaches and unimproved terrain up to 45-degree slopes. The improved all-purpose vehicle can operate safely in 5 ft of salt water. Photographs of the vehicle in operation are given with details of the design.

LIGHT ASSAULT BRIDGE. This is a 33 ft span scissoring type bridge mounted on the M-113 Armoured Personnel Carrier. There is a photograph and outline details of design are given.

CALIBRATING THE WORLD'S LARGEST TELESCOPE, by Elmer M. Peddrick. The construction of the Arecibo Ionospheric Observatory was described in an article in the *Military Engineer*, Nov-Dec 1963. The uses to which this telescope have been put are described in the article. It consists of a reflector 1,000 ft in diameter made of ½ in steel wire mesh curved to be part of a sphere. The accurate calibration of such a construction was essential. The difficulties met with and the method finally used are described in a short well-illustrated article.

AEROSPACE RESEARCH CENTRE, by A. J. Moore. There are five major testing laboratories at Arnold Aerospace Research Center: the Aerospace Environmental Facility, the Propulsion Wind Tunnel Facility, the Rocket Test Facility, the Large Rocket Facility and the von Karman Gas Dynamic Facility. Tests are carried out to guide design in the supersonic

aircraft field and in the realm of space travel. This article gives the broad outline of the facilities provided for the Services and the National Aeronautics and Space Administration, with examples of actual tests which have been carried out. There are photographs of the installations. The scale of the Center is very impressive.

FLOOD PREDICTION IN KOREA, by Colonel I. M. Rice, Corps of Engineers. A brief description of the organization laid on by the Corps of Engineers in Korea by means of which accurate estimates of the progress of flooding, particularly in the valleys of the Hamn and Imjin rivers. In the absence of flood-protection works the only precaution that can be taken is timely evacuation. The organization provides the necessary data.

WALKING MACHINE STUDIES, by Ronald A. Liston. A very interesting article, well illustrated, describing the progress which has been made in the design of a vehicle which walks instead of running on wheels. Nature does not use the wheel and for traversing uneven or boggy ground the leg is better than the wheel. Work is proceeding on a prototype quadruped.

CATHODIC PROTECTION IN MILITARY HOUSING, by Lieut-Colonel Lindsay M. Applegate, Army of the U.S. (Retd). A detailed description of the way in which prevention of corrosion of the exterior of gas, water and underground heating mains can be assured by means of a protective current. There are good illustrations and diagrams.

AERIAL FLASHLIGHT PHOTOGRAPHY, by J. R. Quirk. After a brief history of the development of flashlight photography, the article goes into the optical problems involved and becomes one of more interest to specialists than the general reader.

MILITARY ENGINEER FIELD NOTES

RUBBERIZED-TAR CONCRETE PAVING, by Wilford B. Ballance. Rubberized-tar concrete was developed as a fuel and oil-resistant surface course to prolong the life of old concrete paving. Recently the Corps of Engineers published a rigid specification covering materials control and construction of this type of overlay. This article describes the application of the specification at Langley Air Force Base, Virginia. It is in considerable detail.

AIRFIELD REHABILITATION IN GERMANY, by Lieut-Colonel Maurice B. Rubenstein, U.S. Air Force. The airfield in question was made of PSP and dated from just after the war. The article describes the work involved in restoring the PSP to its original state.

THE MILITARY ENGINEER

MAY–JUNE 1967

SHIPWAY BETWEEN THE OCEANS, by Brigadier-General Harry G. Woodbury, jun. A five-man Atlantic-Pacific Interoceanic Canal Study Commission is now investigating when, where, and how a sea-level canal should be built in the American Isthmus. Previous studies and recent forecasts indicate that the capacity of the Panama Canal to transit ships will be insufficient before the end of this century. Three entirely new routes are under investigation, to which must be added the possibility of converting the existing lock canal to sea-level. This article describes the work being carried out by the Commission and discusses the characterisrics of the different routes. The use of nuclear energy for mass excavation is being examined. There are good illustrations.

TURN KEY PROJECT AT TUY HOA, by Major-General Robert H. Kirtin, Director of Civil Engineering, US Air Force. The so-called "Turn Key" concept was evolved to meet the requirement of producing air-base facilities at the Tuy Hoa site on a schedule which would provide for interim operations by not later than the end of 1966 and sustained operations by mid-1967. Basically it meant that a prime American construction contractor under Air Force direction, would take on a packaged job of managing and supervising the entire task. This article gives the general outline of the design of the airfield, but it is principally concerned with administration of the packaged contract.

A MODERN SYSTEM FOR AERIAL MAPPING, by Lieut Colonel Robert G. Livingston, Corps of Engineers Reserve. The AN/USQ-28 Mapping and Survey System comprises equipment mounted in a RC-135 aircraft, designed and packaged specifically, so this article claims, to give the fastest and most accurate means ever devised for obtaining raw geodetic data to fulfil "Class A" mapping requirements. This article contains a description of the equipment and its operation.

CONSTRUCTION FOR APOLLO, by Brigadier-General A. P. Rollins, jun., Corps of Engineers. This article gives a summary, with illustrations, of construction work undertaken by the Corps of Engineers in connexion with the US space programme. The scale of the work is great and the article shows this by describing briefly each project in turn.

MILITARY MICROMAP DISPLAY, by Howard Carr. This short article describes the way in which the Army Geodesy, Intelligence and Mapping Agency (GIMRADA) is developing a microfilm camera and film-processing equipment which will make it possible to project maps and military information using symbols on to a screen. The main difficulty is the acquisition of suitable microfilm maps. How this problem is being tackled is discussed.

DEFENSE STANDARDIZATION PROBLEMS, by Leslie B. Schramm. This article describes the need for standardization of military equipment and the factors which make it difficult to obtain it.

CUMBERLAND RIVER MODERNIZATION, by Colonel Jesse L. Fishback, Corps of Engineers. A well-illustrated account of the way in which the Corps of Engineers have developed the Cumberland river as a waterway 308 miles long, as well as the provision of electric power, flood protection, water storage and recreational facilities. The work started in the early 1900s, but the article deals more with the improvements made to the original works and the new works which are nearly completed.

SS ROOSEVELT. THE SHIP THAT REFUSED TO FAIL, by Captain Julius Grigore, jun., US Naval Reserve. The SS *Roosevelt* was the ship specially designed for Lieutenant Robert Edwin Peary to use in his attempts to reach the North Pole. She was launched in 1905, but it was not until 1909 that she reached Grant Land, 174 miles from the Pole, enabling Peary to complete the journey on foot and so to be the first man to reach the Pole.

The article, which is well illustrated, describes the design features of the ship which made it so efficient for cruising in the ice and then goes on to complete her life story, which ended in 1926.

CPM ON THE BANGKOK BYPASS ROAD, by Major Louis J. Circeo, jun., Corps of Engineers. An account of how CPM was used for the planning of the construction of the road. There is a good deal of detail and the value of the Critical Path Method is well brought out.

OPERATION QUICK PISTA, by Major Harry C. Hoffman III, Corps of Engineers. A pista is an airstrip, and this article describes the construction of one in Panama to open up an area which is accessible only by road.

MILITARY ENGINEER FIELD NOTES

MINIPADS FOR HELIPORTS, by Lieut-Colonel George M. Bush, Corps of Engineers. Most of the airfields on the east coast of Vietnam are sandy or dusty in the dry season, and during the take-offs and landings the helicopter downblast raises thick swirling clouds of dust, causing damage to engines and rotor bearings as well as blinding the pilots. This article describes how the difficulty was overcome by the construction of "minipads", 24 ft square, of PSP after the application of peneprime, a new dust palliative of asphaltic base.

OPERATION DEEP JUMP, by Captain Neil A. Smart, Corps of Engineers. Rivers and streams in Korea are relatively shallow, but in many cases a narrow, deep gap in midstream makes them unfordable. This article describes how the difficulty of placing a section of bridge over this deep channel was overcome.

TUNNEL RAT RESCUE. The tunnel rat is a soldier exploring Viet Cong tunnels. He runs the risk of being cut off by a cave-in, booby traps or enemy action 200 yards from the entrance. This article describes a method of locating the soldier by using a mine detector above ground co-operating with one carried by the tunnel rat.

J.S.W.S.