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THE ROYAL ENGINEERS JOURNAL

CONTENTS

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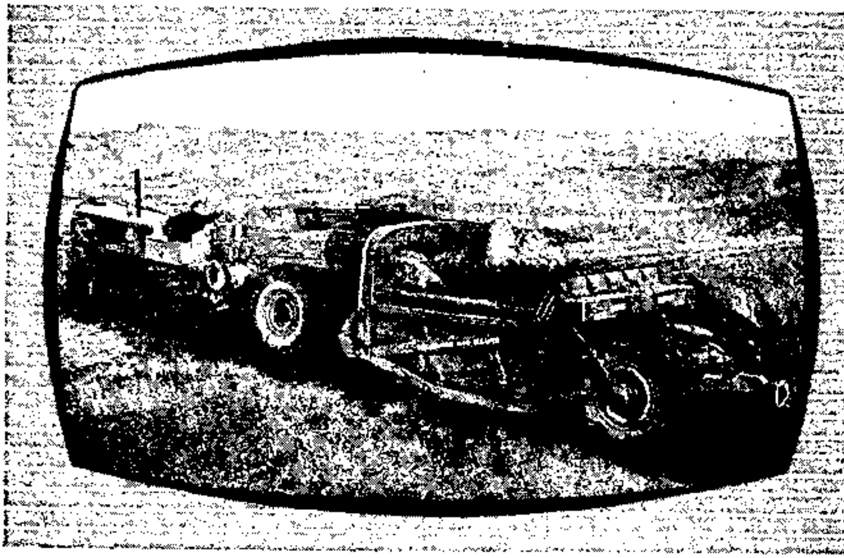

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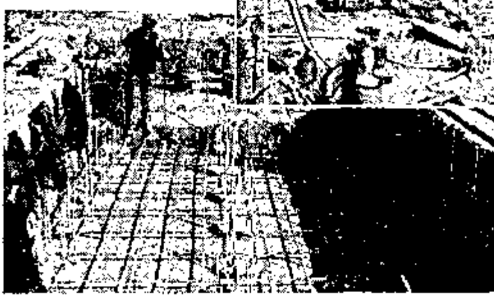

The heavy foundation loading from this building made normal footings for the columns out of question—a condition frequently obtaining today when higher storeys are permitted. Piling was necessary and the close proximity of other buildings, including a hospital, precluded the use of heavy driving equipment with its accompanying noise and vibration.

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THE ROYAL ENGINEERS JOURNAL

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VOL. LXX CONTENTS DECEMBER, 1956

THE COUNCIL OF THE INSTITUTION OF ROYAL ENGINEERS

(Incorporated by Royal Charter, 27th February, 1923)

Patron—HER MAJESTY THE QUEEN

4,050. 1.12.56.

INSTITUTION OF ROYAL ENGINEERS

CONDITIONS OF MEMBERSHIP

1. The following officers are entitled to Full Membership of the Institution:—

   (*a*) All serving or retired regular commissioned officers of the Corps of Royal Engineers.

   (*b*) All officers serving, or who have served, in the Royal Engineers branch of any of the auxiliary forces in the U.K., such as Army Emergency Reserve, Territorial Army, Supplementary Reserve, Special Reserve or Militia, etc., or who hold, or have held, short service, temporary or emergency commissions in the Corps of Royal Engineers.

   (*c*) All officers serving, or who have served, in the engineer arm of the land Forces, whether permanent or otherwise, of:—
   (i) The Commonwealth.
   (ii) The Colonies or Dependencies.
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2. All officers referred to in sub-paras (*b*) and (*c*) above, shall be eligible for Associate Membership instead of Full Membership, if they so desire. Civilian officers of the British Works Services Staff are also eligible for Associate Membership, if recommended by the Senior Engineer Officer of the Command in which they are serving.

3. The entrance fee and annual subscriptions are as follows:—

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5. Associate Members receive free copies of the *R.E. Quarterly Journal*, but not the *Monthly Supplement* or the *R.E. List*.

6. All other publications issued by the Institution, as well as extra copies of free issues, may be purchased at reduced rates by both Full and Associate Members.

7. Associates have no voice in the management of the Institution.

8. All Members resident in Europe are entitled to the free use of the R.E. Library, including free postage one way.

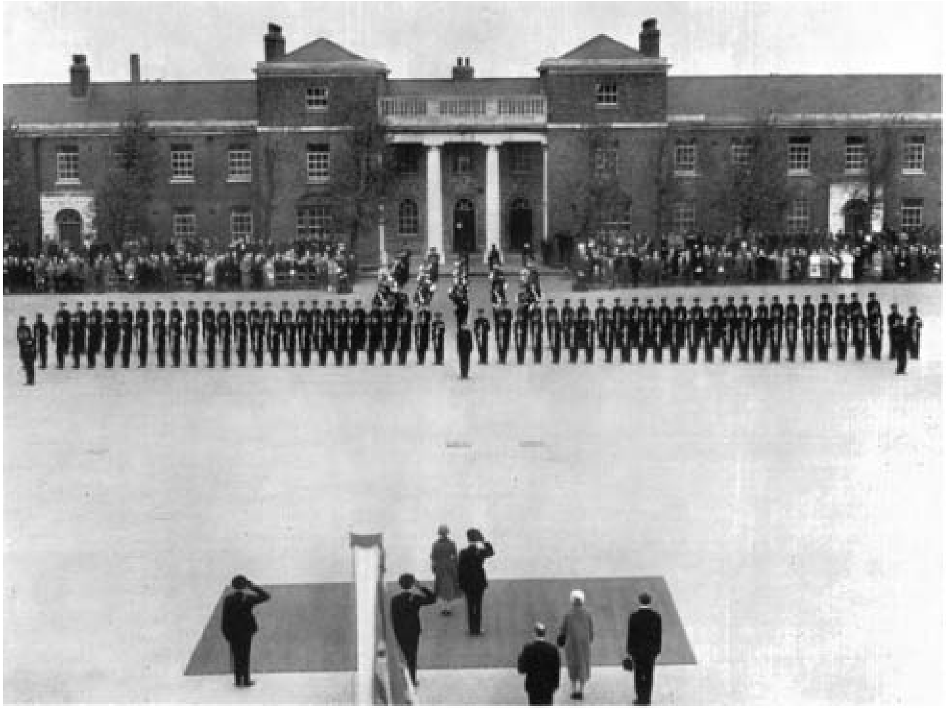

Photo by permission of Chatham Observer

Photo 1.—The Royal Salute

HM The Queen At Chatham 1

H.M. THE QUEEN'S VISIT TO CHATHAM

By COLONEL E. N. BICKFORD

ON 24th October, Her Majesty The Queen, as Colonel-in-Chief of the Corps, visited the Headquarters of the Corps at Chatham. The date was chosen as the nearest possible to the centenary of the incorporation of the Royal Sappers and Miners into the Corps of Royal Engineers on 17th October, 1856. The day was cold but mostly sunny, though there was a short sharp shower at the beginning of the afternoon's demonstration.

Pasley Road was lined by detachments from 12 S.M.E. Regiment and a Guard of Honour, supported by the R.E. Band, Chatham, was drawn up on Brompton Square facing the Orderly Room. A large red carpet was laid as a saluting base. The square was lined on three sides with three rows of chairs, with low stands behind them, and the flower beds on the open east side on either side of the Crimean Arch were gay with chrysanthemums in full flower. There were about 2,400 spectators.

The Guard of Honour, commanded by Major K. M. Robertson, R.E., Second-in-Command, Lieut. P. C. Harvey, R.E., and Ensign 2nd Lieut. A. C. D. Lloyd, R.E., consisted of two divisions each forty-eight strong. It had been planned to make this guard as representative as possible of the Corps by bringing men from all overseas commands, but the Suez Canal crisis severely restricted this and the final composition was Overseas 18 per cent, S.M.E. 50 per cent, Training Brigade 12 per cent, the remainder coming from other U.K. units. For the first time on any Royal Engineer parade the guard wore No. 1 dress, white belts and white rifle slings.

At 12.30 precisely two large cars preceded by a dispatch rider were seen approaching the Crimean Arch and the Guard of Honour sloped arms. To everyone's astonishment the cars stopped and disgorged a number of Press photographers who should have arrived by another gate. This was the only unrehearsed incident in the visit which went like clockwork from beginning to end.

The Queen, who had been paying a state visit to the three Medway towns, arrived a few minutes late. She was received by the Chief Royal Engineer, General Sir Edwin Morris, K.C.B., O.B.E., M.C., who presented to Her Majesty the Representative Colonel Commandant, Major-General Sir J. Drummond Inglis, K.B.E., C.B., M.C., and the E.-in-C., Major-General J. C. Walkey, C.B., C.B.E. The Queen was wearing an emerald-green fitted coat with a black Persian lamb collar, and a close-fitting green hat with black accessories. On the collar of her coat she wore the R.E. brooch which was presented to her by the Corps last year. She was attended by the Lord-Lieutenant of Kent, Lord Cornwallis, and her personal staff, Lady Margaret Hay, Lady-in-Waiting, Lieut.-Colonel The Hon. Martin Charteris, Assistant Private Secretary, and Captain The Lord Plunket, Equerry-in-Waiting.

After these presentations the Queen moved forward to the front edge of the carpet and took the Royal Salute given by the Guard of Honour. After inspecting the Guard the Queen was escorted by the Chief Royal Engineer to the edge of the square, where twelve W.Os. and sergeants and fifteen members of the R.E. Association were presented to her.

The Queen then walked to the Headquarters Mess, where she was to be the guest of the Officers of the Corps at luncheon. Before lunch twenty-five senior officers holding engineer appointments were presented to Her Majesty in the large ante-room, where sherry was served. The remaining officers were served with sherry in the small ante-room and the billiards room. The luncheon was attended by 200 Royal Engineer officers of all ranks who were chosen to be representative of the Corps as a whole.

In the circumstances those attending were mostly from home stations, but the overseas commands were represented by Chief Engineers who had come home for the Engineer-in-Chief's Conference, which was held on the succeeding two days. Territorial and Army Emergency Reserve units were also represented. For the first time the new dinner service badged with the Corps monogram was used, and the Queen's portrait which had arrived a few days previously was hung on the end wall facing the President's chair. This portrait, by Denis Fildes, was a copy by him of his own original portrait commissioned by the Royal Army Ordnance Corps which had been particularly admired by the Queen. When all the officers, with the exception of the Engineer-in-Chief and Representative Colonel Commandant, had taken their places for lunch, the Chief Royal Engineer escorted the Queen and her personal staff into the dining-room—the band playing the traditional music, "The Roast Beef of Old England". At the Queen's request the lunch was a simple one of three courses and the menu chosen by Her Majesty was:—

Melon
Partridge in casserole
Pineapple soufflé

Rupperts Bergerhofstück Spätlese, 1953, Hock was served with lunch.

At the end of the meal the Loyal Toast was drunk in the usual way and it was a greatly appreciated privilege to be able on this occasion to toast The Queen in person. After lunch Her Majesty left with the Chief Royal Engineer to inspect a married soldier's quarter, No. 12 Kings Bastion, occupied by W.O.II Eaton. Her Majesty was shown round by the Deputy Commandant, Colonel E. N. Bickford, and spent a few minutes chatting with Mrs. Eaton about the quarter.

This had been built in 1938 and was the first of thirty-two such quarters to be modernized on a reconditioning programme. The quarter was in all respects a standard one and the furniture was that originally issued to W.O.II Eaton, who had been in occupation five months before vacating it to allow the work to be done.

It was realized early on that there would be considerable jealousy among other occupants and great care was taken to ensure that the quarter was standard in all respects, but this did not prevent a crop of rumours, that the quarter had been specially fitted up in the most luxurious manner, going round the occupants of other quarters and even reaching the Press.

The roads round the married quarters area were lined by detachments from 10 Trades Trg. Regt. R.E., supported by the Garrison Group of Boy Scouts and Girl Guides. The Queen was loudly cheered by all the families who lined the footpaths.

After the visit to the married quarters, the Royal Party drove slowly up to Gordon Barracks through the crowded streets of Gillingham. The route through the barracks to the Bridging Ground was lined by detachments from 11/12 S.M.E. Regiment.

The Bridging Ground had been laid out to accommodate a number of static exhibits as well as demonstrations of modern plant and bridging. Two large stands, holding 650 and 600 respectively, had been built with Bailey equipment and banked earth terraces for seats had been made for additional seats. In all there were nearly 3,000 spectators. In the centre of the principal stand a Royal Box had been built by the workshops staff and trade trainees of 10 Trades Trg. Regt. At one end of the stand was a box for the control staff and at the other a Press box.

The Royal Box was of contemporary design with plate-glass sides and an open front with a staircase on each side leading up to it.

The front wall was carried down to ground level and had a large Royal Monogram on glass in the centre. At its foot was a square paved with stone slabs on four of which were carved the National emblems, the rose, thistle, daffodil and shamrock. There was a small flower bed in the centre.

The newel posts of the staircases and the sides of the box were decorated with castings of the Corps Badge (The Royal Arms) correctly coloured. This is the first time castings have been made of this badge, the pattern of which is complicated and the casting process very difficult in consequence.

The box had a fitted carpet, kindly lent by the Royal Navy, and electric tubular heaters, which as the day was cold proved very necessary. It was decorated in pale blue and white.

On arrival at the Bridging Ground The Queen was met by the Engineer-in-Chief and the Commandant S.M.E., Brigadier G. W. Duke, C.B.E., D.S.O., who conducted her round the static exhibits which formed the first part of the afternoon's demonstrations.

The first three exhibits were provided by the E. & M. School at the S.M.E. and were described by Lieut-Colonel J. E. L. Carter, M.B.E., M.C., R.E. The first in this section was the portable stationary steam engine built at the S.M.E. in 1823, which is believed to be the oldest working engine of its type in Great Britain. This was quietly chugging away developing its magnificent output of $\frac{1}{4}$ h.p. under the control of a Sapper suitably dressed in the working dress of a Sapper and Miner of the period. In contrast, next to this museum-piece was a modern gas turbine coupled to a generator. This set is designed to be easily portable and has a hand starting device to save weight. The Queen, who was very interested in it, commented on the hand starting which struck her as being somewhat primitive for such a modern machine. Her Majesty having been warned that it would make a deafening noise, it was started up and run for a few moments only.

Again in sharp contrast there was the heavy modern 300 kV. transportable field power station for the generation and transmission of electrical power in the field.

In the next exhibit a workshop lorry, provided by the Trades Training Wing of the S.M.E., under command of Major C. R. Obray, R.E., formed the core of a typical field workshop, such as might be operated by a field park squadron. This was being run on a production basis, and steel shackles and wooden door frames were being made.

Lieut.-Colonel R. C. Gabriel, R.E., then showed The Queen the Transportation Centre's mobile van, which displays a working model of a military port and railway system. This was complete with models of docks, ships, electric trains and even cows in the fields. Besides being of great interest to grown ups, this is of particular interest to boys and it seemed a pity Prince Charles wasn't there to see it.

Next in the line was a Map Reproduction lorry operated by men from the School of Military Survey under command of Lieut.-Colonel M. H. Cobb, R.E. This was engaged on the final process of an actual order for the R.A.F. of a 9-colour 1/1,000,000 map of Bahrein Island, in the course of which the last two colours were being printed at the rate of 2,500 copies an hour. Other mapping exhibits were on view in the lorry, including stereographic photographs of Windsor Castle.

The last static exhibit was a small pond showing models of floating bridges and rafts. These ranged from the Class 9 Folding Boat Equipment to the latest Class 70 Heavy Raft. In charge of this exhibit was Lieut.-Colonel P. M. Bennett, O.B.E., R.E., Chief Instructor of the Field Engineer School.

The stands were sited for the active part of the demonstration and static exhibits could not be seen from them. For this first twenty minutes, therefore, the spectators had to sit and wait. To fill in this

Photo by permission of Soldiers' Magazine

Photo 2.—General Sir Edwin Morris, the Chief Royal Engineer, greeting Her Majesty on arrival at Brompton Barracks.

Photo by permission of Soldiers' Magazine

Photo 3.—Her Majesty being presented to Senior Warrant Officers and Sergeants.

HM The Queen At Chatham 2 & 3

Photo by permission of Soldiers' Magazine

Photo 4.—Her Majesty inspecting the Guard of Honour at Brompton Barracks with the Commander of the Guard, Major K. M. Robertson.

Photo by permission of Chatham Observer

Photo 5.—The Grandstand and Royal Box at Gordon Barracks. Two fork lift wheeled trucks demonstrating.

HM The Queen At Chatham 4 & 5

Photo by permission of Soldiers' Magazine

Photo 6.—The Old—Her Majesty inspecting the oldest known working steam engine built by the R.E. at Chatham in 1823. Officers in photo are Lieut.-Colonel J. E. L. Carter, C.I.E. & M. School, Brigadier G. W. Duke, Commandant S.M.E., and Major-General J. C. Walkey, E.-in-C.

Photo by permission of Soldiers' Magazine

Photo 7.—The New—A modern portable gas turbine engine.

HM The Queen At Chatham 6 & 7

Photo by permission of Soldiers' Magazine

Photo 8.—Models of floating bridges and rafts.

Photo by permission of Soldiers' Magazine

Photo 9.—A Centurion tank crossing a tank bridge previously laid by a special Bridge-laying tank.

HM The Queen At Chatham 8 & 9

rather dull period the R.E. band paraded in front of the stand and played a programme of martial music.

Having finished her inspection of the static exhibits, Her Majesty walked to the Royal Box where she was accompanied by her personal staff, the Chief Royal Engineer, the Engineer-in-Chief and the Commandant S.M.E.

The second part of the demonstration was devoted to plant of various kinds. In addition to wheeled and tracked dozers, excavators and graders, two fork lift trucks were shown, and a mechanical mine layer train laid and covered a row of anti-tank mines in front of the stand. Perhaps the most spectacular of the excavators was the small hydraulic digger. This has an ingeniously articulated shovel arm, vaguely reminiscent of a praying mantis, which greatly intrigued the spectators.

Bridging was the subject of the third part of the demonstration and a detachment of 66 Independent Field Squadron built a bay of the new heavy girder bridge using the latest type of bridging crane. A heavy girder bridge 178 ft. long was then launched over the very large dry gap in front of the stands.

Then followed the armoured assault bridging of various widths of dry gap. First an A.V.R.E. laid a fascine and crossed over it; then two bridge layer tanks formed a bridge over which a Centurion tank crossed. Finally two "Ark" tanks linked themselves together, dived side by side in a most dangerous looking manner down the very steep side of the gap and then formed a bridge over which a Conqueror tank was driven. The fighting tanks were provided by the Royal Scots Greys and were driven with great dash. The linked "Arks" and the Conqueror made a most impressive finale to the demonstration.

The R.E. band then took up position in front of the Royal Box and the following officers concerned with the demonstration were presented to Her Majesty:—

Colonel A. G. P. Leahy, O.B.E.
Lieut.-Colonel M. J. J. Rolt, R.E.
Lieut.-Colonel B. G. Bloomer, R.E.
Major T. G. Glendenning, R.E.
Major C. F. Brown, R.E.
Major D. R. Carroll, R.E.
Major J. S. E. Drake, M.B.E., R.E.
Major A. Young, A.R.C.M., R.E.

By this time the Royal cars were drawn up and, after saying goodbye to the Chief Royal Engineer and the Engineer-in-Chief, The Queen drove off round the demonstration ground on her way to Gillingham Station. As the car moved the National Anthem was played and the Royal Standard on the Royal Box was struck. Just before the Royal cars left the bridging ground The Queen was given three cheers by all the spectators.

The B.B.C. had of course been informed of the Royal visit and had expressed considerable interest in it. In addition to providing a sound broadcast they paid us the striking compliment of making a live television broadcast of forty-five minutes of the mobile part of the demonstration. This broadcast which was excellently done was repeated in a shorter recorded form later in the evening. In addition the whole visit was covered by newsreel cameramen and it is hoped to acquire from the best of these sources a complete film record of the visit for the Corps. The best of the press photographs are being collected into a large album which will be kept in the Corps Library.

In the evening, in honour of the event, 10 Trades Trg. Regt. organized a spectacular firework display in Kitchener Barracks. Later, the three W.Os. and Sgts. Messes of the S.M.E. combined to give a Centenary Ball in the gymnasium, which was attended by the Representative Colonel Commandant, the Engineer-in-Chief and a large number of officers and their wives. It was a cheerful and successful affair which was a fitting conclusion to a very memorable day.

The following telegram was received from Buckingham Palace on 25th October:—

> "General Sir Edwin Morris Chief Royal Engineer. I was most impressed by all I saw at the School of Military Engineering this afternoon. Please convey my warm congratulations to all who planned and took part in the demonstration which I greatly enjoyed—ELIZABETH R."

On 26th October, the Chief Royal Engineer received the following letter from the Assistant Private Secretary to The Queen:—

> I am quite sure that you realized yesterday how very greatly The Queen enjoyed her visit to the Headquarters of the Royal Engineers. Her Majesty has commanded me to send you an expression of her thanks and appreciation for the really admirable arrangements which were made, and to ask you to convey it to all concerned.
>
> The Queen greatly enjoyed the lunch in the Headquarters Mess and the opportunity it gave her to meet so many distinguished members of the Corps. Her Majesty is most grateful to her many hosts for having entertained her so well and so kindly.
>
> The Demonstration at Gordon Barracks was an unqualified success and The Queen spoke of it afterwards with the highest praise. As Her Majesty said in her telegram to you yesterday, she thoroughly enjoyed it and found it of the greatest interest."

To these the Chief Royal Engineer has replied as follows:—

> "Will you please present my humble duty to Her Majesty The Queen, and thank her on behalf of all ranks of the Corps of Royal Engineers for her most gracious message.

We regard the visit of our Colonel-in-Chief to Chatham as an inspiration and a great honour to the Corps as a whole, and it will always be remembered with abiding loyalty and affection."

In addition to Her Majesty's personal Staff and the Lord Lieutenant of Kent the following officers had the privilege of lunching in the Mess.

(A) Officers who were also presented to Her Majesty:—

The Chief Royal Engineer, General Sir Edwin L. Morris.

The Representative Colonel Commandant, Major-General Sir J. Drummond Inglis.

Engineer-in-Chief, Major-General J. C. Walkey.

Colonels Commandant:—

Generals.—Sir Kenneth N. Crawford, Sir Brian H. Robertson, Sir Frank E. W. Simpson, Sir John F. M. Whiteley.

Lieut.-Generals—Sir Philip Neame, Sir Ronald Mac K. Scobie.

Major-Generals.—N. A. Coxwell-Rogers, Sir Eustace F. Tickell.

Other Officers:—

Major-Generals.—H. C. W. Eking, W. G. Fryer, C. R. Price, J. C. T. Willis.

Brigadiers.—R. A. G. Binny, W. J. Cardale, G. W. Duke, R. N. Foster, L. F. Heard, The Lord Napier of Magdala, C. H. R. Smith, B. E. Whitman.

Colonels.—B. S. Armitage, W. H. Hooper, P. T. Wood.

(B) Officers lunching but not presented:—

Major-Generals.—W. S. Cole, J. G. Cowley, A. J. H. Dove, R. W. Ewbank, C. P. Jones, C. L. Richardson, A. C. Shortt, H. H. C. Sugden, G. N. Tuck, R. W. Urquhart.

Brigadiers.—G. F. Atkinson, P. D. G. Buchanan, L. F. de V. Carey, H. P. Drayson, T. H. F. Foulkes, M. C. A. Henniker, F. W. Houghton, P. P. Jackson (R.A.E.), A. H. M. Morris, O. J. R. Orr, C. C. Phipps.

Colonels.—E. N. Bickford, E. S. de Brett, D. I. Burnett, A. H. G. Dobson, J. N. Drew, F. M. Hill, A. R. Mais, J. G. A. J. O'Ferrall, C. G. Stainer, T. Wright.

Lieut.-Colonels.—P. A. Adams, P. M. Bennett, B. G. Bloomer, W. T. Calvert, J. E. L. Carter, R. O. H. Carver, J. S. Close, M. H. Cobb, W. G. F. Jackson, P. C. Grant, R. R. L. Harradine, R. E. Holden, A. C. R. Hughes, J. Lamb, E. J. Le Febvre (Fr. L.O.), J. F. McKenna, D. C. Merry, G. C. S. Montanaro, P. M. Morris, O. S. Pearson, S. A. T. Radcliffe, S. G. Saunders, A. P. Smith, H. M. C. Smith, B. B. Spiridion, J. Vaughan-Williams, C. E. Warth, C. D. Waters, F. W. Watson, R. Weld, J. C. West, A. G. White, M. D. Wilkinson, W. F. Woodhall.

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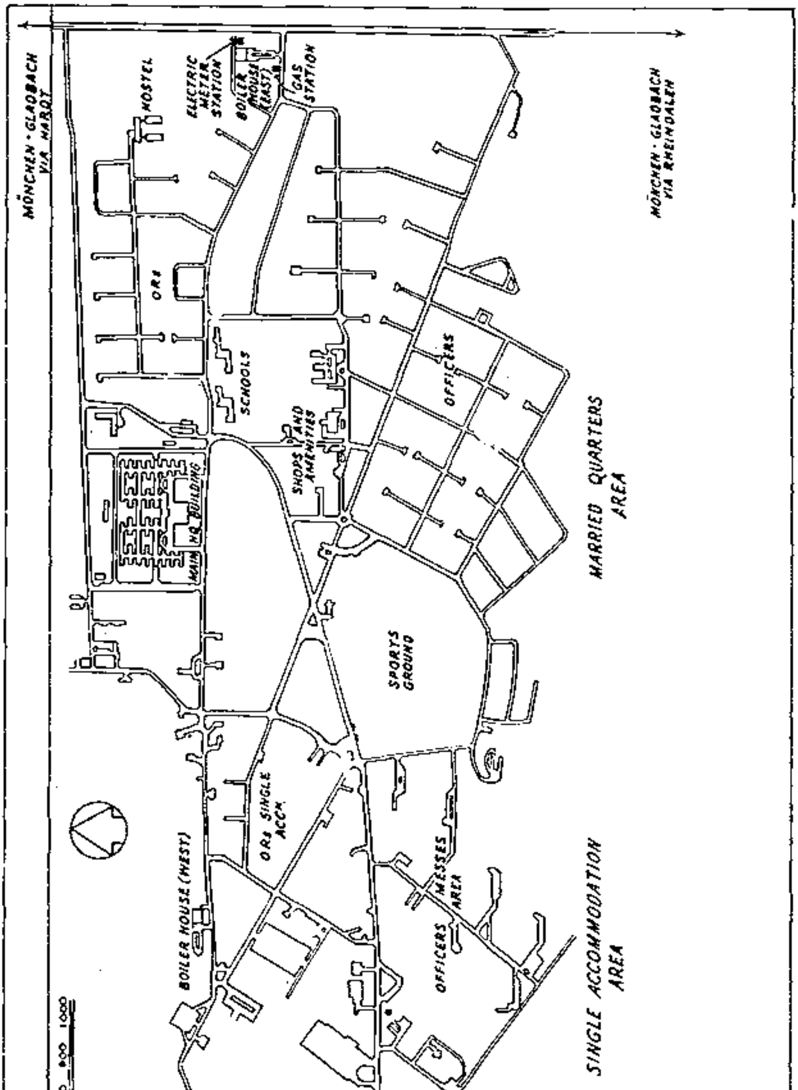
Captains.—H. Ashdown, D. Awdas, C. J. Bewlay, J. L. Booth, D. B. S. Brotherton, I. A. C. Bruce, P. Budd, C. S. Burns, J. I. G. Capadose, F. X. S. Carus, D. O. Caton, E. P. H. Coles, F. A. Cronk, W. P. C. Dawton, D. M. R. Eagan, E. R. Elderkin, I. K. Evans-Gordon, R. S. Faulkner (R.A.E.), A. P. Fitzsimons, D. Francis (R.C.E.), S. J. Fuest, P. A. Gallard, E. R. Goddard, A. J. Hacker, E. X. Halliday, R. A. Harrison, D. S. Jeffery, M. D. King, G. Laycock, S. D. Lewis, J. May, A. J. W. McCoy, J. A. McKay-Forbes, J. G. MacSwiney, G. R. Mills (R.A.E.), B. W. Mortimore, G. C. Negus, P. L. Newth, J. S. Nobbs, A. B. O'Hagan, D. J. D. Overton, A. M. Packer, C. B. Pollard, N. J. B. Prescott, D. G. Raschen, M. R. Rich, D. A. Richards, C. F. Rose, P. Sherburn, R. T. D. Sullivan, R. R. Thompson, T. H. Tozer, J. J. M. Walker, R. Wheatley, M. V. W. Wright.

Lieutenants.—G. J. Chave, M. S. Curtis, C. M. Ellis, I. G. Graham, R. B. McGuire, M. J. Punnett, P. B. Whitestone.

2nd Lieutenants.—G. D. Bailey, J. A. M. Evans, D. N. Hall, C. P. M. Ind, W. W. Marks, M. A. Pocock, E. R. M. Pringle, N. J. Whatley.



NEW HEADQUARTERS IN GERMANY

NEW HEADQUARTERS IN GERMANY
E. AND M. WORK

By Major D. White, M.B.E., R.E.

Introduction

THIS paper, based on the author's experiences and observations as S.O. II (E. & M.), is a digest of the E. and M. work and problems which occurred during the planning and construction of the Joint Headquarters for Northern Army Group and 2nd Allied Tactical Air Force near Moenchen Gladbach, in Western Germany. This large scale project was started in autumn 1952, when the site was a densely covered wood, and blossomed into permanent working, living and playing accommodation for some 8,000 in autumn 1954, rising to 9,500 by spring 1955. The over-all planning from the Chief Engineer's viewpoint and a general description of the project has been described by Colonel H. Grattan, C.B.E., in another article published in the *R.E. Journal* for March and June, 1956. It is hoped that some of the unusual technical features which arose, although in this instance influenced or decided by the particular circumstances, may provide food for thought for others who have to deal with a similar project.

There is an essential need for E. and M. to be thoroughly co-ordinated into the main over-all building construction plan, since although E. and M. services are ancillaries of the building proper they are very much an integral part of the whole. The main progress plan needs to be devised so that E. and M. fits into its appropriate places. For example, on this project the services to be buried alongside or under certain roads were H.T. and L.T. electric cables, telephone cables, water, gas, sewage, rainwater drainage pipes, and high and low pressure heating mains. The same roads also had to carry large quantities of building materials. Unless these often conflicting requirements had been carefully phased in a proper sequence, much unnecessary work and acrimony as well as waste of time and money would have resulted.

Project E. and M. Requirements

These can be summarized into the four main headings of heating and domestic hot water, cooking facilities, electricity and water. It had already been decided that heating and domestic hot water for all buildings (including 800 married quarters) was to be by a district heating system. As town gas was readily available from the local supply authority (about five miles from the site) this was selected for cooking in married quarters and the main cooking load of clubs and messes. Steam cooking also for messes and clubs could be supplied from the district heating system. Electricity, for lighting chiefly, was available in sufficient quantity from a local public supply. Water could be made available from a local public supply, but would entail expensive development of the existing public facilities. It was hoped that a water supply could be found and developed within the site, and fortunately this proved to be possible.

As the project developed its scope was increased, initially by an extra 100 married quarters within the original site and finally by the addition of an area for 250 married quarters, three messes and a school on the south-west edge of the original site. This S.W. extension which came after the original scheme was well advanced, necessitated a separate district heating system. The other E. and M. services for S.W. extension were provided by extensions to the original supply facilities. The loads which eventually had to be dealt with, including S.W. extension, were:—

(i) Heating—installed—40,000,000 kilo-calories per hour—maximum demand—32,000,000 kilo-calories per hour.

(ii) Domestic hot water—maximum demand—7,000,000 kilo-calories per hour.

(iii) Steam cooking—maximum demand—2,500,000 kilo-calories per hour.

(*Note:* 1 kilo-calorie = 3.97 British Thermal Units.)

(iv) Gas—installed—9,000 cubic metres per hour—maximum demand—2,500 cubic metres per hour.

(v) Electricity—installed—10,000 kW.—maximum demand—3,800 kW.

(vi) Water—maximum demand—3,300 cubic metres (726,000 gallons) per day.

District Heating

(a) Primary Considerations

As the district heating requirements for S.W. extension were quite different from those for the main site, they are dealt with separately in this paper. In the original project the first things to be decided were:—

(i) Number and siting of boiler houses.

(ii) Type of system to be used.

The siting of boiler houses is a complex problem involving many factors. Apart from economic and obvious technical points such as being as near as possible to the centre of the load, others such as access for fuel delivery, fuel storage space, availability of water and electricity, drainage, prevailing winds affecting smoke direction have to be carefully assessed. In this project two of the most important factors were the varied nature and size of the loads in winter and summer, and the disposition of buildings. The site, some 3,000 metres long E. to W. and 1,500 metres wide N. to S., was virtually divided by building layout requirements into two approximately equal squares. One of these was to be taken up entirely by married quarters and hostels, and the other by single accommodation and administrative buildings, with common user amenity buildings (schools, churches, shops, etc.), more or less in the centre between the two areas. The key building (Northern Army Group and 2 A.T.A.F. Main Headquarters Block), with by far the greatest individual heating requirement, was also roughly between these two areas, to the north.

For these reasons primarily, the best solution was to erect two boiler houses—one to serve the East married quarters area, and the other the West single accommodation area, with the Main H.Q. building forming the point of interconnexion between east and west systems so that it could be supplied from either. Later it was decided to interconnect the east and west systems at two other points, so that in emergency, or in summer when no heating was required, one boiler house would be capable of supplying the comparatively small domestic hot-water requirement to the whole site.

(*b*) *Selection of System*

The first step towards this was the detailed calculation of the loads to be dealt with. Heating requirements were based on a minimum outside temperature of -12°C. (10°F.). The inside temperatures varied of course with the type of room, but living accommodation generally was designed for $+18$°C. (65°F.). The total installed heating load thus calculated came to:—

(i) Area East less main H.Q. building = 13,500,000 kilo-calories per hour.

(ii) Area West less main H.Q. building = 15,000,000 kilo-calories per hour.

(iii) Main H.Q. building = 5,500,000 kilo-calories per hour.

The domestic hot-water requirements were calculated on the provision to each married quarter of 90 litres (20 gallons) per hour at 65°C. (150°F.). For other buildings, allowances were made for baths, sinks and lavatory basins based on scales prescribed in D.F.W. T.I. 672.

From this the total domestic hot-water commitment at lowest outside temperature came to:—

(i) Area East—2,850,000 K/cal/hour.

(ii) Area West—3,550,000 K/cal/hour.

The third load to be calculated was the provision of steam for operation of large cooking appliances in messes, clubs, etc. These appliances—wet steaming ovens, steam jacketed boiling pans, hot closets, bains marie, tea boilers and plate-washing machines—can be operated by a direct steam supply from mains or a local generator, or by individual steam raising coils heated by other means. In any case they represented a heat load of 2,500,000 kilo-calories per hour.

The whole of this load was in Area West so that normally it would be supplied from that area's boiler house.

Thus the total connected loads under lowest outside temperature conditions, allowing for the main H.Q. building being supplied from either boiler house, came to:—

(i) Area East—Heating		19,000,000 k/c/hr.
D.H.W.		2,850,000 k/c/hr.
	Total	21,850,000 k/c/hr.
(ii) Area West—Heating		20,500,000 k/c/hr.
D.H.W.		3,550,000 k/c/hr.
Cooking		2,500,000 k/c/hr.
	Total	26,550,000 k/c/hr.

To obtain the most economical running of the systems over the whole year, bearing in mind the diversity between summer and winter loads, it was decided to use High Pressure Hot Water as the basic source of heat supply. The system pressure of 10 atmospheres (atu) provides a maximum flow temperature of 175°C. (347°F.) and a normal return temperature of 90°C. (194°F.). Early consideration was given to a three-pipe system in which the flow for heating services only is in one pipe and that for D.H.W. and cooking loads in a second, using a common return. However, it was found more suitable and economical to use a two-pipe system supplying a number of substations for heating and D.H.W., with a direct H.P., H.W. supply to buildings requiring steam for cooking.

The substations were equipped with heat exchangers containing primary coils fed with H.P., H.W., transferring heat to a separate secondary circuit circulating low pressure hot water through radiators. The L.P., H.W. system has a flow temperature of 95°C. (204°F.) and a return of 60°C. (140°F.). In the substations also were fitted domestic hot-water storage calorifiers, heated by H.P., H.W. coils, to supply the same buildings as the particular substation fed with L.P., H.W. heating. The size and disposition of substations ranged from the large special building to supply forty married quarters, to a calorifier room in a mess, club, etc., supplying only that building. In the married quarters area all substations were built below ground, in some cases as an extension of the cellar of a quarter. In the West area substations were generally above ground, sited as far as possible to harmonize with the surroundings and serving a complete unit group, e.g. an officers mess with its five associated living blocks.

(c) Boiler House

The division of the site into two approximately equal load areas enabled the same basic design to be used for both boiler houses, as well as the same make, type and size of boiler. In addition, as far as possible ancillary boiler house equipment of the same makes and types was specified—with the object of simplifying maintenance. The size of the boilers was decided in some measure by availabilities in Germany at the time. Despite these limitations the size selected had certain technical advantages in view of the type of load.

The selected boiler has 125 m^2 of heating surface with a nominal output of 2,000,000 k/cals. per hour. Allowing for mains losses (estimated at 6–7 per cent), diversity of total installed load to maximum demand, overhauls with boilers out of commission plus a little for future extensions it was decided to install ten boilers in East and twelve in West boiler house.

The essential technical features of the boilers are:—

(i) Chain grate stokers 3·6 metres long by 1 metre making a grate area of 3·6 m^2, electrically driven through a four-speed gear box to give rates of 1·7, 3·0, 6·0, or 10 metres per hour.

(ii) Induced draught capacity 10,000–18,000 m^3 per hour.

(iii) Forced draught capacity up to 8,000 m^3 per hour.

Ash extraction is by worm gearing operating beneath the grate. The flue gases are passed through cyclonic grit arrestors into two chimneys 17 metres high. Normal operating conditions are 13–15 cm. depth fire bed, using Fettkohle Nuss 4 (British equivalent steam coal 12–18 per cent volatiles 10–18 mm. size nut), draught 38–40 mm., CO_2 13–15 per cent, giving an output of 3,200 kg. of steam per hour. Fuel consumption under these conditions averages 0.55 tons, per hour, per boiler.

The fuel handling arrangement was designed to reduce as far as possible the number of men working per shift. Above each boiler was installed a 10-ton capacity hopper. These hoppers are fed by an electric overhead travelling gantry grab (1-ton capacity) from the outside fuel storage bunker. The latter has a total capacity of 1,300 tons and to facilitate unloading from tip wagons was built as a large pit below boiler house ground level. By this arrangement stoking is achieved by one coal crane operator per shift.

(d) Main Heating Circuits

In the boiler house the steam from the boilers is passed through two main headers to a central steam distribution equipment, from which a main circuit and a number of subsidiary steam operated boiler auxiliary equipments (feedwater pumps, feedwater storage tank, etc.) are supplied. The main steam circuit passes to a hot-water generator consisting of a double cascade and H.P., H.W. storage vessel. From the hot-water generator the H.P., H.W. passes through circulating pumps into the main lines of the H.P., H.W. network. The return from the network passes back to the hot-water generator through a main mixing bypass valve system which regulates network flow and return temperatures in relation to the quantity and pressure of the steam fed into the cascade and the heating load of the network.

In the first year of operation H.P., H.W. circulated from the boiler houses ranged from 50 tons per hour in summer to 380 tons hour winter in East area, and from 120 tons hour summer to 480 tons hour winter in West.

(e) Distribution System

To deal with the scattered loads it was necessary to install twenty-nine substations in East area and forty-two in West area, supplied from three main lines in East and five in West. Connexion between the two areas was made at the substations on the ends of the three lines from East boiler house. All H.P., H.W. piping is of seamless steel with welded joints, and ranges in size from 191/180 mm. (7.5 in.) to 76/70 mm. (3 in.) diameter. This piping was tested to 26 atu for 12 hours minimum before being insulated ready for service. To allow for expansion, loops were provided at about 80 metres distance with fixed points midway. The pipes were laid in brick walled, concrete base and cover ducts, protected at all joints by bituminous water-proofing. They were installed at a depth to ensure a minimum earth cover of 60 cm.

Considerable discussion took place before the type of insulation to be used was selected. Eventually it was decided to use vermiculite (very small "exploded" mica chippings) on normal piping runs, with conventional glass wool packing on certain road crossings and expansion/inspection points. The types of insulation considered, against the factors of cost, type of ground and speed of installation, were glass or stone wool in normal large ducts, cellular concrete round the pipes direct in the ground, various types of prefabricated materials direct in the ground and vermiculite in small ducts. Each has its merits, but perhaps the greatest advantage of vermiculite is speed of installation. Once the piping is laid in the open duct the vermiculite is tipped into the duct and quickly covered, thus avoiding long delays due to inclement weather, as with the other types. The experience gained from installation and twelve months service of this comparatively new type of heating insulation suggests that it is technically very suitable for use where soil is dry, but could not be recommended with any confidence for damp ground. In cost vermiculite worked out at about the same as cellular concrete and approximately 13 per cent cheaper than for conventional glass wool insulation in ducts.

(f) L.P. Heating

With the exception of garages, where H.P., H.W. unit heaters were used, all buildings on the site were heated by L.P., H.W. radiators or convectors. The latter were used only in places where the space under windows prevented installation of radiators. In clubs, cinemas, churches and similar buildings the L.P. heating system was combined with a forced ventilation system, in which the air is blown over heating coils before entering the room. The circulating L.P., H.W. temperature is controlled by outside thermostats which operate the valves on the H.P., H.W. coils of the heat exchangers. The L.P. distribution system was laid and insulated in the same manner as for the H.P. system—the same duct being used also to accommodate domestic hot-water supply pipes.

The larger substations were equipped with two heat exchangers, each large enough to supply approximately 75 per cent of the maximum load. As the latter occurs over only four to six weeks of the heating season the substations are adequate to deal with equipment breakdowns. This reserve of heat exchanger capacity also allowed for extension to the heating system of a substation, a precaution which was more than justified in this project.

(*g*) *Domestic Hot Water*

The calorifier capacities were designed to store hot water at a maximum temperature of 70°C. to avoid excessive scale formation caused by storage at higher temperatures. However, during periods of very cold weather the storage temperature was adjusted to 80°C. Thus, designing for 70°C. storage provided the necessary reserve to maintain the supply during a very cold spell. In the married quarters area storage calorifiers were installed in only six substations—those at both ends of the three main H.P., H.W. lines. The two storage substations for each main line were coupled together and routed through the intermediate heating substations. The hot-water circulation for each substation area was then pumped from its own substation. By this system each substation could be supplied with hot water from one or both of the storage calorifier stations, at the ends of its main line. In addition the storage calorifiers in the three substations interconnecting East and West systems were equipped with duplicate H.P., H.W. heating coils. One of these was connected direct to East and the other to West area and was intended to allow for the shut down of East area's boiler house in summer.

(*h*) *South-West Extension*

The decision to add S.W. extension to the project was made more than a year after planning for the original scheme had commenced, and entailed the supply of:—

(i) Heating—5,500,000 k/cals. per hour.
(ii) Domestic hot water—600,000 k/cals. per hour.

Being a fairly compact residential area consisting almost entirely of married quarters (about 250), it was apparent that the load did not warrant a 10 atu H.P., H.W. system with heat exchanger stations. Instead, a system providing a direct hot-water connexion from boiler house to quarters at 1.5 atu pressure with normal flow temperature of 115°C. and return of 60°C. was adopted. Three calorifier stations, one, part of the boiler house, and the others annexes to garages, supply the domestic hot-water requirements.

The boiler house was equipped with four boilers of the same size, and generally of the same type as those installed in East and West boiler houses. To carry on the policy of saving operating man power, while benefiting economically from experience gained in the construction of the main site boiler houses, the new boiler house incorporated some new features. Of these the most important was the construction of the boiler house almost entirely below ground level, made possible by the very suitable nature of the soil. The siting of the boiler house was decided largely by the limited space available for the number of buildings to be fitted into the S.W. extension, and the site which eventually was available for the boiler house strengthened the decision to go underground.

The main fuel storage bunker, which has a capacity of 400 tons, butts against the vertical side wall of the boiler house. From this wall it slopes upward to the road so that fuel can be tipped direct from road wagons. From the base of the bunker the fuel is transferred by individual boiler belt conveyors inside the boiler house to the hoppers above the boilers. Ash is ejected mechanically at the back of the boiler into steel barrows which are raised by a small electrically operated lift to an ash storage bunker. This bunker built alongside the main chimney is bridged across a small road so that the bunker contents can be dropped into the disposal wagons.

The hot-water output of the boilers passes into a common expansion/storage vessel and thence is pumped round the three circuits into which the area is divided. The external distribution system was installed in a similar manner to that of the main site, using vermiculite for insulation. Finally, to simplify the system and reduce cost the steam cooking appliances in the messes and school in the extension were not connected to the boiler house, but are equipped for gas. Sufficient quantity and pressure of gas was already available from the main site system to make this economically possible.

(*j*) *Pipe Requirements*

The extent of the district heating installation for this project may perhaps be gauged from the quantity of piping required. Including the S.W. extension, some 550 km. were necessary for external high and low pressure heating and domestic hot-water distribution. A further 250 km. were required to complete internal services in the various buildings.

GAS

Barrack Synopsis lays down that gas will be the first choice for cooking in normal circumstances. At the H.Q. site this presented no difficulty from an availability point of view, as the near-by town of Moenchen Gladbach was ready and able to supply all the needs. It is worth mentioning in passing that Germany has a highly organized gas grid system covering the country in a similar manner to the electricity grid in Great Britain. The major source of this town gas is the Ruhr from which gas is piped at varying pressures to local municipal authorities who distribute it to individual customers.

After negotiation with Stadt Moenchen Gladbach Authorities, arrangements were made for a bulk supply at 0.3 atu pressure to be made to a new regulator station. This was located at the east end of the site in the boiler house enclave and 5.5 km. of 200 mm. diameter pipe were necessary to connect it to the Stadt mains. From the regulator station gas is distributed round the whole site through 42 km. of pipe ranging in size from 400 mm. to 50 mm. diameter. Gas is used for domestic cookers and wash boilers in all married quarters and for large ovens and grills in messes and clubs. The site distribution is designed and automatically regulated to provide a consumers pressure of 60–70 mm. water gauge (0.006–0.007 atu). To prevent the small moisture content in the gas freezing in very cold weather the pipes were laid at a minimum depth of 80 cm. In addition some 250 water collecting pots which are looped below the normal pipe level were installed in the gas lines.

ELECTRICITY

(*a*) *Initial Temporary Suppy*

To enable building work, especially roads, to be commenced without delay, a temporary overhead line system at 5,000 volts from an adjacent public supply was installed, paid for out of project funds. This supply was connected to hired portable transformers which were moved round the site as necessary for the work in hand. The L.T. supply from the transformers to contractors was metered and paid for by the contractors direct to the supply authority. The provision of this temporary supply obviated the need for contractors providing their own generating plant, an alternative which would undoubtedly have resulted in a heavier charge on the project funds.

(*b*) *Permanent Electricity Supply*

Although the near-by 5,000-volt public supply used during the construction period was of insufficient capacity for the full needs of the occupied H.Q., a public supply at 15,000 volts of sufficient capacity was available some four kilometres away. In view of the considerable saving in time and initial cost it was decided to connect the site to this supply rather than construct a site generating station. In addition, by the obtaining of a favourable bulk supply tariff rate from the local authority it was fairly certain that there would be saving in running costs, compared with locally generated electric power.

The obvious disadvantages of having the whole site dependent on one underground cable were offset by the installation of standby diesel generating sets at key buildings. Places so covered were the main H.Q. building and telephone exchange, where the set installed is of the automatic mains failure type, and the boiler houses, waterworks, sewage pump house and similar buildings. Because of the increase in load since the H.Q. was first occupied it has been decided to connect it to a second public supply derived from a separate source by a cable following a different route.

The original 15,000 volt public supply terminates at a bulk metering transformer substation located in the East boiler house enclave. From this substation a 15,000 volt underground cable ring main feeding thirteen transformer substations covers the site, with a further four substations, including S.W. extension connected to the ring as spurs. Each substation is equipped with two or three similar transformers of either 315 kVA. or 200 kVA. capacity and suitable isolating H.T. control switchgear. The second public supply is being connected to another point on the ring with its own bulk metering equipment.

(c) Low Voltage Distribution

From the substations the low voltage network at 380/220 volt three-phase was inter-connected to eighty-two outdoor steel kiosk type feeder pillars, so that each feeder pillar can be supplied from at least two substations. The feeder pillars were equipped with local fuse protection for the distribution service cables connected to them, thus enabling speedy location of faults and minimum isolation of consumers in fault conditions. In all, some 90 km. of underground cable were necessary for this network.

The load to be supplied was chiefly lighting and in this connexion the extensive use of fluorescent tubes must be mentioned. All offices on the site, including nearly 2,000 in the main H.Q. building, as well as kitchens, dining rooms and other rooms requiring high intensity illumination were lit by standard German 40-watt tubes 1 metre long. In addition, mess ante-rooms and similar places were lit by recently developed 32 watt circular fluorescent tubes in suitable fittings. Two other features of the internal electrical installation were:—

(i) The use in all but damp situations of rubber covered, plastic insulated wiring buried in plaster.

(ii) The installation of miniature circuit breakers instead of the normal British pattern melting fuses.

This type of wiring has the merits of cheapness, speed in erection and concealment without, as far as experience to date has shown, loss of efficiency or safety. Miniature circuit breakers obviate the need for the laborious and sometimes dangerous business of finding and fitting fuse-wire. The circuit breaker button requires only to be pushed back to remake the circuit, unless the nature of the fault prevents this being done.

(d) Road Lighting

Some thirty-six kilometres of road were required to be lit and on the scales for Class A and B roads laid down in Barrack Synopsis meant the provision of 617 lighting standards. The type selected was a hexagonal section concrete standard with curved overhang standing 6 metres above ground and buried 1.2 metres. The standard is fitted with an aluminium alloy hooded fitting and cylinder type glass in which is installed 75 or 120 watt mercury discharge bulbs (equal in light output to 300 or 500 watt tungsten bulbs). The necessary control gear is housed at the base of the standards into which is looped the underground cable supplying it.

Groups of lights operated by time switches are connected to the nearest transformer substation. The siting of road lights was a tricky problem because of the many underground services which had to be avoided when excavating for the standards. However, it proved possible to position the lights generally at 1.2 metres from the edge of the road, which gives the required degree of illumination on the road surface.

Water Supply

(a) Primary Considerations

As with any other large building project the first consideration was the immediate provision of water for building purposes and then the development of a permanent supply in time for occupation. For the first, a 125-mm. pipe line was laid connecting the site to the nearest available public supply, about five kilometres away. This incidentally was one of the first works contracts for the combined H.Q. project. The quantity of water available, 1,000 cubic metres (220,000 gallons) per day, while ample for building requirements was far too small for the permanent needs. It was therefore necessary to appreciate the alternatives of contributing a large sum to the public authority to increase their available quantity to 3,300 cubic metres per day or of developing a site water supply. The considerations of running costs, control of system and pressure, particularly in regard to fire-fighting hydrants, as well as the purely military advantages made the latter much more attractive, but of course depended on whether sufficient water was available.

In spite of discouraging German geological opinion, preliminary "sapper" investigations of the locality, to say nothing of emphatic assurances from a "dowser" of no little experience and success in other parts of the world, indicated that a large part of the site had water-bearing strata. It was decided to sink a trial borehole together with 3-gauge bores over an area of about 2,000 square metres, and if and when water was found, to carry out quantity pumping tests to observe fall in levels. In the event ample water was found in a sand and gravel stratum five to ten metres in depth sandwiched between two impermeable black clay layers. This water layer was only twenty to twenty-six metres average depth below ground and the total source was eventually estimated to be about twenty-seven square kilometres—enough to provide for forty years!

In addition the water was of exceptional quality.

(b) Boreholes

Where the trial boring perforated the upper clay layer the water rose by artesian effect 10 metres above the water stratum. During pumping tests the level dropped until at a sustained pumping rate of 100 cubic metres per hour the level remained stationary 1 metre above the water stratum. When pumping was stopped the water level recovered 80 per cent of its drop in 10 minutes and to the full artesian rest level in 3 hours. As a result of these tests it was decided to sink four permanent boreholes equipped with submersible borehole pumps of 100 cubic metres per hour output. This meant that the maximum daily requirement could be obtained by pumping two boreholes for 17 hours or three for 11 hours. By operating a systematic pumping cycle, adequate rest periods on each borehole are assured.

The boreholes were located in relation to the site, by then selected, of the proposed new waterworks and reservoir. Care had to be taken that they were at least 50 metres clear of any possible source of contamination, which in German law means any type of construction as well as the obvious sewage lines, etc. In the event, the boreholes were located at points 250 metres north, 300 metres south-west, 350 metres south-east and 400 metres north-east of the waterworks. The boreholes are 800 millimetres in diameter and below the pumps are packed with a 200 mm. wide ring of washed gravel forming the primary filter. At the top of the borehole is the well-head equipment incorporating the main valves on the 200 mm. diameter rising main, metering equipment and starter gear for the electric motor of the submersible pump. The starters for the pump motors are wired back to the waterworks main electrical control panel to push buttons for remote control start and stop.

(c) Water Works

This consists essentially of storage capacity for at least 24 hours, the necessary water treatment plant and pumping equipment for site distribution. The storage requirements are provided by two underground concrete reservoirs of 1,900 cubic metres each. The remainder of the installation is built between the reservoirs to form a compact and self-contained water-works. From the boreholes water is pumped into an aeration chamber and thence via filter chambers and sterilization plant to the reservoirs. A separate system then pumps treated water through pressure vessels into the distribution network.

The aeration plant which is to precipitate the iron content and remove part of the carbonic acid consists of two chambers each of 38 square metres and 4 metres high into which the raw water is sprayed through sparge pipes. The water is then directed by baffle plates into the filtering chamber immediately below the aeration rooms. Three filter beds, each capable of dealing with 300 cubic metres per hour, comprise the filtration equipment. They contain "Magno", an alkalizing agent which removes the precipitated iron and slightly increases the hardness and pH values. Cleaning of the filter beds is effected by back flushing pumps, assisted by compressed air blown up through the base of the beds. The filtered water is sterilized by a chlorine gas solution automatically injected in the line between filters and reservoirs. It is adjustable and normally set to ensure a chlorine residual of not less than 0·1 parts per million.

From the reservoirs water is pumped by three electric driven 150 cubic metre per hour pumps into four interconnected pressure vessels, each 2.8 metres diameter and 4 metres high. The upper portion of the vessels is normally charged with compressed air to give a maximum pressure of 6 atmospheres. This pressure provides the maximum head necessary for site distribution to all consumers. As water is drawn off the pressure vessels by use in the distribution mains, the pressure falls. At 4 atmospheres the pumps automatically cut in and replenish the vessels until 6 atu pressure is restored, when they automatically cut out. Depending on the rate of consumption in the mains one, two or three pumps start up to ensure the pressure does not fall below 4 atu. The four pressure vessels hold a total of 75 cubic metres (16,500 gallons) which is the immediate source of supply for site demands.

For initial charging and for the occasional topping-up of the pressure vessel air cushions two electric-driven air compressors were installed. Other features of the waterworks are that all main valves are hydraulically operated, also the provision of a well equipped laboratory. This has direct connexions to each source of raw and treated water for testing and sampling. Finally the provision of a standby generating set as well as the precaution of having more than one of each of the various machines, etc., provides adequate safeguard for the maintenance of this most important function.

(*d*) *Distribution*

From the waterworks, distribution is by cast-iron pipe buried 1.2 metres deep to safeguard against freezing, ranging in size from 250 mm. dia. to 80 mm. dia., with service connexions of 38 mm. or 50 mm. Joints on the main lines are screwed and on service lines welded. All main lines are interconnected and metered to give efficient control and easy isolation. At maximum draw-off, loss of head over the system to the most distant consumer is less than 2 atu. One hundred and fifty hydrants are connected to the larger pipes of the main distribution system for fire-fighting water supply. The pressure vessels at the waterworks can be speedily adjusted to give 7 atu pressure for this purpose. In all, a total of 21.5 km. of water piping was used for water distribution on the site.

ENGINEERS IN THE EMERGENCY IN MALAYA, 1954/56

By Brigadier W. F. Anderson, C.B.E., M.C.

Introduction

The main rôle of engineers in any war is to provide mobility for our own forces and to deny it to the enemy.

Hence, on one side of the picture, roads and airstrips and on the other mines, obstacles and demolitions.

Malaya follows the general pattern, only there is nothing that can be done to deny mobility to an enemy who is on his feet, except to restrict and destroy his food supplies; the other peculiarity of Malayan operations is that they have been prolonged over a period of nearly eight years; under these conditions mobility involves a considerable bill for temporary accommodation.

I. Camp Accommodation

This is never a spectacular engineer task, but it has by far the most important logistical effect on operations, besides representing the greatest engineer effort.

Success in eliminating bandits depends, amongst other things, on "numbers in the jungle"; men are only too easily frittered away on escorts, camp details, rear parties, and a host of other minor duties, many of which arise from dispersion or inferior living conditions.

Malaya is a large country, and bandit activities have been widely dispersed over it; although the active enemy units generally speaking stay in fairly well defined geographical areas, dictated by security from attack and access to sources of food and funds, the security forces are never strong enough to mount effective offensive operations everywhere simultaneously; consequently, the weight of "teeth arm" forces is liable to shift from one bad area to another once or twice a year; again, a sudden success by the security forces, such as occurred in 1955 in Pahang, may result in the clearing up of a large tract of country and in redeployment elsewhere.

It is easy to talk of living rough and of making do with self help and improvisation; the "teeth arm" units do all of these things habitually in the jungle on patrol and in company and regimental bases; none know better than the sappers that some of them are better at it than others, but in general they are pretty good.

On the principle, however, that any fool can be uncomfortable, and remembering also that these units must on no account divert men from their task in the jungle, it is common sense to make them reasonably comfortable in Company and Regimental bases and to aim at providing at least the following:—

Water supply.
Good cooking arrangements.
Adequate and hygienic washing and sanitary arrangements.
Some form of floor (slab or PBS) to tents or basha shelters.
Electric light.
Refrigerators.

There is a further factor which is important. The warm, damp climate of Malaya reduces the life of tentage to about twelve months, so that it becomes just about the most expensive form of accommodation possible; various quite successful attempts have been made to develop a galvanized iron or aluminium portable substitute, but the fact remains that the cheapest and most comfortable temporary dwelling is the attap basha hut with a jungle roller or sawn timber framework. This simple structure can be improved by the addition of an asbestos roof and weatherboard sides, and where the length of tenure justifies it this is often done either at the start or later; standard drawings and bills of quantity cut down the design work considerably.

Lastly, as all except African units come to Malaya with families, or hope to do so, there is a large demand for temporary married quarters. These have been built with tentage, with attap or with weatherboard, depending on the expectation of tenure; the most recent development is a sectional wooden prefab, capable of being dismantled and moved at least twice in its seven years of life, at about 20 per cent of its first cost; identical sections are used to build quarters for Europeans or Asians.

Obviously, it is not possible to do everything on first occupation; financial control ensures that very little is undertaken lightheartedly or for very short periods of tenure, so that there is a continual demand for repair, renewal and improvement; although the individual services are generally small, together they amount to a very considerable building load, and in the nature of things there are a great many that are planned and for one reason or another never carried out.

The table below tells the story of the work on temporary accommodation over the last three years:—

Year	Value of Services in £		Contracts Let	Regt. Bases		Coy. Camps		Temp. M.Q.	
	Planned	Built		Built	Maint.	Built	Maint.	Built	Maint.
1953/54	500,700	486,500	46	2	25	8	56	318	429
1954/55	364,300	251,600	45	2	27	11	54	54	747
1955/56	377,200	240,000	34	1	25	38	109	46	801
Average	414,000	326,000	42	2	26	19	73	140	659

This work has been done by a variety of methods, conditioned by the circumstances:—

The breakdown, roughly, is as under:—

(*a*) Fixed Price Contract on B.Qs.	60 per cent
(*b*) By Term Contractor on measurement	20 per cent
(*c*) By directly employed labour	9.9 per cent
(*d*) By Agency using P.W.D. or Estate Managers	10 per cent
(*e*) By Engineer Troops	0.1 per cent

The above percentages are a pretty good index of the general merits of these methods; not all commanders at all times have agreed on this verdict, but experience has endorsed it, for the following reasons:—

(*a*) Work by Term Contractor or Direct Labour is often the only way of getting small jobs done; nevertheless it demands much supervision and we are always short of this.

Term Contractors, moreover, have an exasperating habit of exercising their right to terminate their contract if things do not work out to their liking; besides which, as their rates are quoted for odd jobs, it is obviously wasteful to employ them on large or easy ones.

Direct Labour is generally frowned on as being wasteful and this is true, but there are exceptions; in large, sparsely inhabited States such as Pahang, contractors just will not quote for small jobs, nor often will term contractors function.

Under these circumstances a G.Es' Works Section in a lorry with all its stores aboard is the best and often the only answer.

(*b*) Agency services are nearly always unsatisfactory as they tend to take a very low priority in the programme of the agent, who is also very thin on the ground in outlying areas and neither knows nor cares much about Army urgencies. In the interest of good relations all round, they are best avoided.

II. Air Communications

The end of World War II left Malaya well equipped with Dakota airfields at the principal towns and these were quickly developed for Civil Airlines.

With some additions and extensions, these airfields have proved adequate for all the heavier air support operations, such as air strikes, supply and leaflet drops, voice aircraft broadcasts, photography, and long distance communication flights.

The principal sapper task has been in the development of airstrips for light aircraft, and this has been a rather remarkable by-product of the emergency.

The first seven years after the war saw twenty-four airstrips built, of which eleven were built by the P.W.D. for Beaver feeder services, and thirteen to Auster standards by the Army for military communication flying and recce.

Most of these airstrips have been in continual use by the Air O.P. Squadron, whose close recce of the jungle for signs of camps or cultivations has been one of the main sources of information about the enemy.

In 1952, the High Commissioner introduced helicopters as a new means of carrying the war into the deep jungle, and in the train of the helicopter came the Jungle Fort, designed to enable the Security Forces to live in and dominate the most inaccessible tracts of swamp and mountain, and to win over the 40,000 aborigines who at the time were dominated and used by the bandits.

This policy was a great success, but at one time it looked as if it might be greatly retarded by a shortage of helicopters; there were all sorts of mechanical teething troubles and at one time serviceable availability fell to five machines; at the same time, fresh uses for helicopters developed every day—evacuation of casualties, of captured enemy for interrogation, or of corpses for identification, commanders' visits, tactical troop lifts, crop destruction by spraying and so on.

It was obvious that there would always be far more helicopter missions than helicopters, and that the sooner some of their tasks could be taken over by fixed wing aircraft, the better.

The prototype Pioneer aircraft arrived in Malaya in November, 1953; clearly, this promised to be an enormous relief to helicopters if airstrips could be built at the Jungle Forts to take it; not only would its operating costs be lower, but it would get to outlying forts quicker and in worse weather—helicopters cannot fly through cloud and are not good in turbulent conditions.

The construction of Pioneer airstrips for the Jungle Forts was both an engineering and aeronautical challenge. In order to fulfil their function, the forts had been sited in the most inaccessible parts of Malaya, usually separated from the nearest road or railway by twenty or thirty miles of swampy or mountainous jungle; the aborigines in the neighbourhood were few in number and small in stature, and unused to any kind of digging tool; the earlier forts had been located for nearness to water and to aborigine settlements at a time when airstrips were not considered a possibility; it was clear that most strips would involve earthwork well outside the range of hand labour, and that anything other than a grass or earth surface would be ruled out by logistics; the approaches and the air conditions would be such that the aircraft would be operating up to the very limit of flying, with no margin of error for turbulence or bad surface conditions.

In early 1954, the need for airstrips was considered so urgent and important that the High Commissioner called for a special report on ways and means; sapper units at that time amounted to a Malayan Field Squadron and Field Park Squadron, just operational; the aborigines, as has been seen, were an untried and doubtful proposition; Chinese building contractors might possibly have tackled the task, but their price would have been very high, and they would have been difficult to maintain and a bad security risk; the High Commissioner was prepared if necessary to recruit special pioneers for the work, but this would have taken some considerable time to set in motion.

The most promising lines seemed to be field sappers and the local aborigines, reinforced with airportable earth-moving equipment, and a start was made early in 1954 on developing appropriate techniques.

The easiest and most accessible strip, at Fort Kemar, was given to a N.S. sapper subaltern and twelve Malay sappers with authority to employ as many aborigines as he could find, and to pay them ready cash from an imprest that dropped literally from heaven.

At the same time, inquiries and experiments were put in hand with all the importers of agricultural tractors and machinery with the idea of developing airportable earth-moving equipment; none of the W.D. tractors would break down to anything near the 800 lb. limit of the S.55 helicopter, and the only suitable equipment in the country at the time appeared to be the 26 h.p. Ferguson wheeled tractor.

Leave was given by the Federation to buy one and try moving it in pieces by helicopter; it worked; four more were ordered at once and a variety of towed tools were made up by a Fd. Pk. Sqn. Workshops to supplement the stock Ferguson equipments.

A tractor was flown in to Fort Shean and it successfully moved about 5,000 cu. yds. of earth to build a strip in just under three months, and was then taken to pieces again and flown into Kemar, just in time to complete the compaction and final levelling of the work that the hand labour party had done with about thirty aborigines.

Much had been learnt about aborigines in those three months; it was found that they could contribute quite a lot, given good man management and an example. It was best to keep the sapper party quite separate, clearing roots by explosives and levelling, and to put the aborigines on to tree felling and burning, at which they were experts.

Quite apart from its output, it was found that the tractor had the enormous advantage of compacting the soil and of evening out all minor bumps with a drag or a towed scraper blade.

Once the technique of dismantling and reassembly in the field had been mastered, it was obvious that the tractor was the key to the problem, with sappers for assembly and operation; sappers also cleared roots with explosives, leaving aborigines to do tree felling, revetting and grass planting.

As larger and more difficult strips came along, it became necessary to find a bigger and better tractor; the first 38 h.p. Fordson County Tractor arrived in Malaya in November, 1954, and was immediately used by the agents for a demonstration of portability by helicopter; it survived its test and was bought and four more were ordered.

In this way a very respectable airportable tractor fleet has been built up, which now amounts to five Ferguson and eight Fordson tractors; the Fordson does the rooting and earth-moving and is followed up by the Ferguson for the finishing and "gardening" operations. Being new, the tractors have given very little trouble, in spite of having been taken to pieces in the field three or four times; they will probably last about two years, in the course of which they will have built four or five different airstrips each.

As regards the airstrip surface, grass dropped in bags and dibbled in at 6-in. intervals took very well and spread to form a dense mat within four months; it was found that a strip could be put to occasional use under good weather conditions as soon as it had been planted without appreciable damage to the grass.

Later on, the trouble lay more in curtailing growth than in encouraging it; a lush, thick carpet is not a satisfactory surface for Pioneers, as it makes the aircraft sluggish in acceleration on take off and tends to promote skidding under heavy braking.

Various potential unpaid grass cutters were tried out; goats, geese and ducks were flown in by helicopter, but each in their several ways proved a failure; the goats disliked all long grass but went for the short tufts and above all the roots, which they pulled up; the geese would only touch grass that had already been cut for them; and the ducks had little interest in grass but a great enthusiasm for puddles which they did their best to enlarge into ponds. One after another, they were down-graded from the status of "airfield ground staff" to "rations on the hoof" and liquidated.

In the end the best results were obtained by aborigine "hockey players" swinging a bent piece of iron, or by an autoscythe flown round from fort to fort.

In one case where there were outcrops of soft laterite rock, this was spread as a surface and no grass planting was done.

Not all the strips were built by airportable equipment; wherever there was a possible means of access for a heavier tractor, it was used, and some interesting and valuable experience was gained in the process; at Fort Dixon, a D4 dozer was broken down into one ton loads and carried to the site in country dug-out canoes, up some twenty miles of river and over several rapids; at Fort Langkap, two D8 dozers were walked in through four miles of jungle, cutting a track as they went; at Pengerang, access for plant was made by sea, using a pontoon equipment raft.

The larger plant should have made these tasks a simple matter; in practice, however, such was the age and state of repair of the equipment that breakdowns were frequent and the effort spent on flying in fitters and spares disproportionate; at Langkap, for instance, the helicopter effort spent in attending to two D8 dozers over a period of six months was £4,200 which would have half paid for a single new D7 tractor that would have finished this task in half that time.

In general, the more remote or urgent the task, the more vital to go to it with new equipment.

The following lessons were learnt:—

(*a*) In the mountainous parts of Malaya, it will seldom be possible to site an airstrip more than 300 yards long without running into disproportionate engineering difficulties.

(*b*) A good constant for a Fordson tractor under these conditions is 3,000 cu. yds. per month and for a Ferguson 1,000 cu. yds. per month.

(*c*) Viewed purely from the helicopter hour point of view, the airstrips began to pay a dividend after being in use for about five months.

(*d*) Viewed from the point of view of cost, the airstrips in most cases pay a dividend after being in use for about thirty-one months.

(*e*) In cases where Pioneers were used to replace airdrop as a means of supply, the airstrip paid off after fifteen and a half months.

(*f*) In general had the tractors and operators been available, it would have paid in most cases to fly in three or four tractors instead of one or two and to have had the strips for use correspondingly earlier; the cost of evacuating the tractors by air was usually greater than their residual value.

Apart from its value to the emergency, the experience in the construction of light airstrips with airportable equipment was valuable in itself and could have useful extensions to a major war in other theatres.

Similar tractors could be dropped in on palettes in large numbers to build airstrips for Beverley or other freight aircraft in forward areas in a short time, and having done their task could be used to distribute the supplies by sledge or trailer.

III. Road Communications

Introduction

For a country of its size and recent development, Malaya can boast of a very fine system of high grade, black surfaced, main roads; nevertheless, there are enormous areas of comparatively habitable country that are not fed by so much as a cart track, and there are yet larger areas of swamp or mountainous jungle, quite close to towns or main communication arteries, where roads have hitherto been found too difficult and expensive.

Since the war, for various reasons, the general tendency as regards roads has been to consolidate what has been won; there has been strong opposition to earth feeder roads or to anything that will create a big maintenance problem for the future.

The World Bank Mission of 1954 was rather critical of this policy;

Photo 1.—Fort Dixon Airstrip. A Ferguson tractor brought by boats in pieces has been assembled and is being hauled up the river bank by Malayan Sappers.

Photo 2.—Fort Dixon Airstrip. A Size IV tractor, brought to site in boat loads, being assembled.

Engineers In Malaya 1,2

Photo 3.—Rompin-Gemas Road. General view of the road constructed by British and Gurkha Engineers.

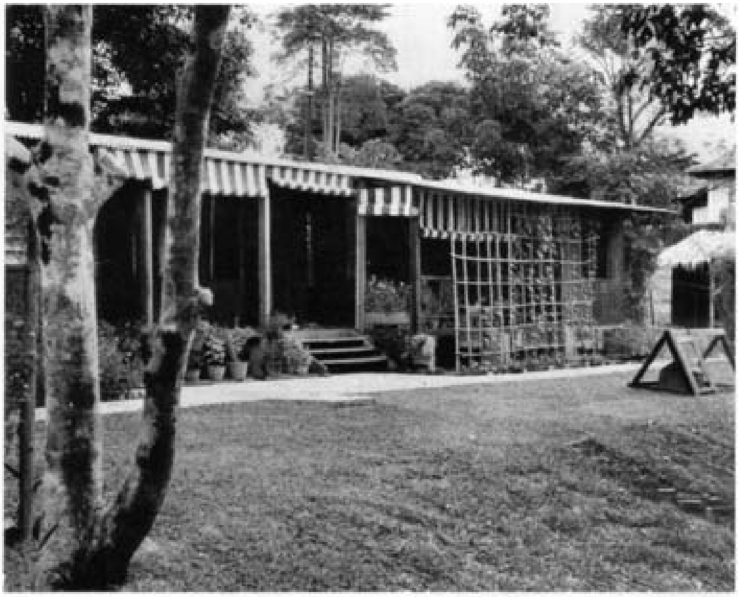


Photo 4.—Pre-fabricated married quarter built at Kuala Lipis.

in their opinion the main roads were good enough as they were and the feeder roads far too scarce for a healthy economic development.

Certainly from the bandits' viewpoint this rather lopsided development of communications has had great advantages; nothing suits them better than a tongue of inaccessible swamp or mountain running down to a town or large communication artery; they can extort from the towns or estates, or ambush on the roads and get back into the bad lands before the security forces can catch up on them.

As the security forces gain the upper hand, the bandits tend to retreat into the more remote bad lands, but they must retain some link with developed areas in order to live by extortion and constitute a threat to law and order; they tend to avoid the areas with a good network of side roads as they know that security forces can quickly concentrate against them and get behind their line of retreat.

It is always easy to be wise after the event; it is not difficult to see now that an extensive feeder road programme started in 1947 or 1948 would by 1956 have made the operational task of security forces considerably easier than it is; in fact little was done until 1953 and only a fraction of the P.W.D. effort has been put into side roads since that date.

Review of Operational Roads, 1954–6

Since the beginning of 1955, approximately £310,000 has been spent on roads with an operational purpose, on a programme drawn up by the Director of Operations, and approved by the Legislative Council.

The work has been carried out partly by Sappers and partly by the P.W.D., and in certain cases as a combined operation by both.

The standard of road has varied according to its purpose; three categories have been recognized:—

Category A. A road required purely for a specific operation and likely to be abandoned within twelve months.

These are built to Class 9 with ruling grade 1 in 10, width 12 ft. of laterite surface and 20 ft. between side drains, jungle timber culverts.

Category B. A road required for operations but likely to be taken over afterwards by the P.W.D. as a side road.

These are built closely to the P.W.D. specification, which is Class 24, ruling grade 1 in 10, width 16 ft. of laterite surface, 24 ft. between side drains, concrete culverts.

Category C. A road required urgently for operations but also forming part of the planned development of the arterial road system.

The operational road in these cases is sited and built to serve not only for operations but as the construction road for the highway that is intended later; very close liaison is maintained with the P.W.D. from the start to ensure that the alignment and specification meet both requirements; the road is generally similar to Category B, except that bridges are built to Class 30 in order to be able to take the very heavy earth-moving equipment that will carry earth and surfacing material to various parts of the formation when the main road is built.

The follow-up by the P.W.D. is usually fairly quick so that the Category C road is not likely to be in use for more than two or three years.

In some cases, by arrangement with the P.W.D., timber bridges are built that will serve the main road for fifteen to twenty years; in others, bridges are in Bailey equipment, intended to be lifted as soon as the main road bridges are in.

The following table shows the mileages of operational roads built or in building under the sponsorship of the Director of Operations during the last three years:—

	By R.E.			By P.W.D.			Combined R.E./P.W.D.		
	A	B	C	A	B	C	A	B	C
1954	17	—	—	—	—	—	—	—	—
1955	8	4	—	—	20	22	—	—	5
1956	24	18	14	—	35	6	—	—	—
Totals	49	22	14	—	55	28	—	—	5

The military objects intended and achieved by these roads have been various.

The Category A and B roads are used to reach isolated villages, served at present only by river, that are specially vulnerable to blackmail by bandits; to join up estate road systems and thus avoid long detours or dangerous cul-de-sacs for security force vehicles, or to make access between rubber estates and the jungle fringe that will prevent bandits from carrying out food lifts, murder or extortion without fear of effective pursuit.

The Category C roads complete vital links in the chain of main roads, and thus enable security forces to control larger areas with less troops; the forty-two miles of Category C roads at Temerloh–Maran, Rompin–Gemas, and Kemayan–Ayer Hitam will save approximately 240 miles of detour, which shows the military importance as well as the economic value of these missing links.

There are a number more that could well be done; they invariably form part of the long term road programme of the Federation, but it is a question of advancing their priority at the expense of something else.

TECHNICAL LESSONS

All the lessons which have been learned on these roads are in the textbooks, but it is worth repeating some of them:—

(*a*) *Drainage.* The proverbial key to roads, but there are special ways of turning it in Malaya.

In the dry part of the year there will be a deluge twice a week, and in the monsoon once a day, or continuously for two or three days; the commonest time for a downpour is between 3 and 6 p.m. after a sultry morning.

Most of the soils in Malaya compact well and throw off surface water easily, but they can only be consolidated at somewhere near O.M.C. and in the jungle itself one could wait for months to achieve this state; the key to success lies in removing a wide belt of jungle and letting the sun and air get at the soil; if this is done, it will be possible to compact a successful formation without interruption in all but the three wettest months of the year; earthwork in these three months is possible but most uneconomical and should be avoided wherever possible.

(*b*) *Surfacing Material.* Most of the soils of Malaya are clays or silty clays with little hard granular material to bind them; rocks are well weathered for twenty or thirty feet and blasting is seldom required except in very deep cuttings.

The natural soil, properly compacted, is quite capable of taking the wheel loads of ordinary traffic when dry, but it is dangerously slippery when wet, and quickly disintegrates once ruts start to hold water on the surface. The only local material readily available to give a wearing and waterproofing skin is laterite; this occurs as a rule on the higher ground and is found as a red chemical granular deposit three to six feet deep in weathered rock; a good laterite will contain 25 per cent of hard nodules of size from a pea to a marble, and 75 per cent of clay; a poor so-called laterite will contain perhaps 25 per cent of heavily weathered rock fragments which under traffic quickly turn to clay, little better than the formation it is required to protect.

A satisfactory laterite surface requires not less than 4 in. of compacted material and the getting and placing of something like 1,500 tons of laterite soil per mile forms a very large part of any road job; it is usual to find laterite of a sort every five miles or so in most districts.

It is obviously wasteful of effort to cart 75 per cent of clay to place on clay but river gravels are not available and crushed granite or limestone chips are very expensive; as always in road work, there is no one best solution and speed and success depend on a true appreciation of the importance of the soils factor during recce, and on the judgement and enterprise of the individual officer during construction.

(*c*) *Use of jungle timber.* Most roads in Malaya will be built through or near rubber or jungle and in spite of the white ant and the borer beetle, rubber or jungle timber will last for two years in temporary bridges, culverts, or causeways; selected hard woods will last fifteen to twenty years, but these are not easy to come by.

Where timber is plentiful, a very satisfactory temporary causeway over swamps can be made with a continuous timber crib with about two feet of soil placed on top as a surface, with waterways at intervals as necessary; box culverts up to 2 ft. by 2 ft. in section and temporary bridges of 12 ft. span were successfully built to take the construction traffic.

(*d*) *Plant support in the field.* The performance of engineers on roads is largely the performance of their plant, and it must here be said that the output of Sappers on roads in Malaya would have been two to three times greater if their plant had been up to the standards reached by the P.W.D.; the P.W.D. look to get at least 1,500 hours of trouble free running out of a machine after a base overhaul, and dispose of it when this is no longer possible or economic; the Sappers found, by bitter experience, that they could on the average expect serious trouble requiring evacuation to base within 400 to 500 hours for tractors or graders or 700 to 1,100 hours for excavators.

Nevertheless, much was learnt and much was done to improve the performance of plant on roads; the following are the important lessons:—

(1) *Need for unit field workshops.* Neither unit nor L.A.D. fitters can work in rain and mud, and even if they are only going to be in position for three months, it is worth giving them overhead cover, a concrete floor, and an improvised washdown at roadhead; it was found that one such field workshops could effectively support six to eight miles of roadwork and this represented a suitable squadron task; R.E.M.E. sent detachments to squadrons as temporary L.A.Ds. and greatly assisted the repairs and procurement of spares.

(2) *Need for servicing trailers.* With eight or ten items of plant in a squadron sector, it is well worth while having a special servicing squad under the plant sergeant to deal with the machines in the field in turn, with the operators assisting; not only is movement time cut down, but greasing is much better done; to do this work efficiently, one standard servicing trailer is required per squadron.

(3) *Need to concentrate effort.* Field Squadrons are not designed to operate much plant and neither Field Park Squadron nor Regimental L.A.Ds. are designed to be split; it follows that road tasks are best undertaken on a regimental basis; squadrons may be deployed concentrated or dispersed at opposite ends of the road as the tasks and conditions dictate, but allocation of plant, defence tasks and road sectors is much best left to the regimental commander.

In general, it is best to finish one road quickly and reap an operational dividend from it than to have a whole series under construction for a long time.

(4) *Tractor sizes.* There is little to be said for a medium sized tractor for roadwork; the Size 2 or 3 tractors require just the same operating and maintenance personnel as the Size 1, and produce less for it; they are more liable to damage and strain and are not robust enough for tree felling.

The Fordson Major tractor may be slightly less robust than a D4, but it has the advantage of being portable in a S.55 helicopter or in a 3-ton lorry; the Tracked Fordson will do the small jobs quite satisfactorily, but the Tyred Fordson is lacking in adhesion in wet weather.

The verdict therefore is for Size 1 tractors for Plant Troops and Tracked Fordson Majors for field quadrons, with of course uniformity of type and make at least within a theatre.

IV. Other Tasks

It would be surprising if in an irregular campaign lasting eight years, no peculiar tasks fell to engineers, and Malaya is no exception.

There is a natural tendency to look for "bright ideas" and gadgets as a short cut to success; most of these ideas were vetted and sifted by Operations Research, but one or two ended in tasks for the engineers and these are recorded.

The following tasks were undertaken:—

(*a*) *UXB Disposal.* Over a period of three years, some 160 UXB were destroyed, and 220 dumped; these ranged from 500 lb. aircraft bombs to the toy crackers smuggled into the country for Chinese New Year which dried out to be as senstitive as fulminate of mercury, and when stored in bulk a most dangerous explosive.

The main object of UXB disposal was to prevent bandits from extracting the explosive and making their own bombs and booby traps.

(*b*) *Booby traps.* At first sight this might appear an attractive method of dealing with unoccupied camps or difficult ambush positions, but the conditions of jungle warfare were against them.

In the first place concealment of electric leads or disturbed ground was very difficult against expert trackers; further, the locating and disarming of booby traps in jungle would have been a laborious and dangerous operation.

Booby traps, therefore, were ruled out by the "G" Staff; curiously enough the one successful trap was laid by the enemy, in 1956, using an electric firing system.

(*c*) *Deception devices.* Bogus "Death Ray Apparatus" was placed in one area in order to deny it to the enemy, with elaborate "Danger Keep Out" notices and a few explosions at intervals to give the impression of something dangerous.

The enemy reaction to this stratagem was unexpected, and might have produced two kills had a double bluff been used in the form of a booby trap; after a time, curiosity got the better of fear and two bandits crawled up to investigate the apparatus.

The effort spent on this rather elaborate ruse was disproportionate to the results achieved.

(*d*) *Cave demolitions.* The Ipoh area abound in limestone caves which formed an admirable hideout and shelter for C.Ts., and their local knowledge of the inside labyrinth enabled them to defy search parties. The entrances, however, were limited and judicious demolitions effectively blocked them with debris; whether there were any successful "entombed" eliminations was never known.

(*e*) *Helicopter L.Zs.* This was normally an infantry task; in some places, notably swamps, conditions justified the use of engineers, who felled trees on site to form crib piers and covered this with a bamboo mat which in turn was covered with about six inches of soil dug from the swamp.

(*f*) *Illumination.* Towers to carry searchlights were built near new villages, to stop food being taken away at night.

(*g*) *Detection of buried arms.* Mine detectors were used to search suspected ground, but the difficulty was the number of false alarms, which entailed much unnecessary digging.

Conclusions

1. The most important contribution of the engineers to operations in the emergency was the least spectacular: that of temporary accommodation in jungle camps and bases.

2. The next most important, in its actual effect on operational potential, was that of light airstrips for Pioneers. It was unfortunate that this aircraft, and the technique of building strips for it, came so late in the emergency that the full benefit of it was only beginning to be reaped in 1956.

The experience and the lessons for similar operations of the future should prove invaluable.

3. The most important potential contribution to stability after the emergency was the light earth road into undeveloped areas, either to serve isolated villages, police posts or estates, or to act as the construction road for important arterial road links built later by the P.W.D.

If the military resources deployed on roads in 1954/6 had been made available from the start of the emergency, and had been equipped with serviceable plant, at least 500 miles of earth road could have been built, which would have made the task of the Security Forces progressively easier and thereby have shortened the emergency: the P.W.D. effort that was actually deployed on road improvement could have been used to develop some of this earth road into the arterial road links much needed for the economic development of the country.

GURKHA BRIDGE

By Captain P. R. Knowles, R.E.

Introduction

In Malaya one of the great difficulties about fighting the Communist terrorists is the existence of large tracts of jungle. There are very few roads in these forest areas and the movement of security forces is consequently slow and difficult. For this reason a number of emergency roads suitable for troop movement have been built and others are projected.

The Rompin–Gemas road is fairly typical. These two large villages in Negri Sembilan, some eight miles south of Kuala Lumpur, are only ten miles apart as the crow flies. Yet until August, 1955, the journey by road was over seventy miles. For operational reasons a shorter route was necessary between Gemas and Rompin. This short road was projected as a joint Military–P.W.D. task; the Military to build a construction road and semi-permanent bridges, the P.W.D. following on, to build a permanent road.

The job of building the construction road and bridges was given to 50 Field Engineer Regiment with, in support, 410 Independent Plant Troop and work was started in January, 1955.

The new road is cut through heavy primary jungle. Such jungle contains trees up to 180 ft. tall, and a girth of 10 ft. is common. Some three and a-half miles from the Gemas end the road has to cross the Muar River and it is at this point that Gurkha Bridge was built.

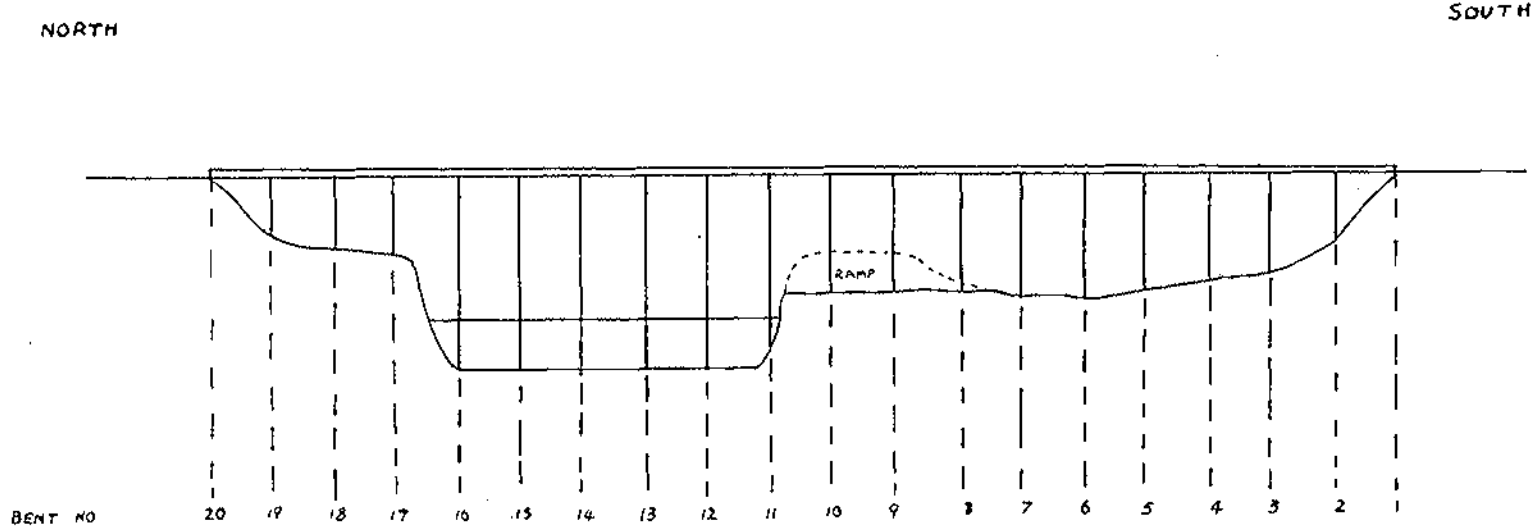
The whole area at the crossing point is covered in thick primary jungle. The trees grow right up to the river bank. On the south side the ground is flat for about eighty yards and then rises, but on the north side the ground rises steeply right from the river's edge. The river itself, is, in summer, about 100 ft. wide from bank to bank. Like all rivers in Malaya its depth is variable. Overnight from a mere trickle flowing over red sandbanks it will become a swift-rushing torrent of brown floodwater. In the dry season there may be, in the deepest spot, only four feet of water.

In the winter this may become twenty-five feet. In addition the whole of the south bank area will be flooded and debris, including jungle timber, will come rushing down on the flood waters. The depth of water in the flooded area will be up to ten feet in the bad winter floods.

Design

The design of the bridge was not an R.E. responsibility, but was done by the P.W.D. Resident Engineer, Rompin–Gemas Road. The general design is influenced by three main factors; the flooding on the south bank, the high-water level in the winter and the limited

FIG. 1.



GURKHA BRIDGE SIDE ELEVATION

NOT TO SCALE

reach of a 19 R.B. pile-driving rig. To cope with winter flooding the first ten pile piers are driven into the south bank winter flood area. Thus the bridge is very long in comparison with the water gap, consisting of nineteen bays of 18-ft. span—in all 342 ft. (see Fig. 1). The high-water level in winter makes it necessary to have the deck level approximately twenty-five feet above mean river bed. It is rather unfortunate that the reach of a 19 R.B. pile driver is only 18 ft. because later events showed that this distance between bents caused too much obstruction in the waterway, leading to scour.

Fig. 2 shows the details of construction, but in addition the following notes may help to clarify it.

Pile Piers. Each pier is made of five 12 in. × 12 in. piles cut from selected hardwood. The piles were supplied in lengths of 30 ft., 25 ft., or 20 ft. The driven lengths were, however, generally greater than 30 ft. so that piles had to be spliced. The distance between piers of 18 ft. is limited by the maximum reach of a 19 R.B. pile-driver when lifting piles weighing approximately one ton.

Capsills. These may appear unusual. They are split, one each side of the pile pier, being held to the pier by bolts passing through the pile heads. The result is neat, but requires more work than the conventional 12 in. × 12 in. timber resting on the pile heads.

Road Bearers. There are six road bearers in each bay. The centre two are lapped and staggered with their opposite numbers in the adjoining bays, but the outside four join directly on to their opposite numbers with a scarf joint. The outside four are held on to the pile heads by a U strap over each scarf joint.

Transoms. These are necessary to transmit the load from the decking to the road bearers. They are at 2 ft. 6 in. centres (approximately seven to a bay) and each one is held to the road bearers by four angle irons.

Bracing. Eight pile piers containing very long piles have, as well as diagonal bracing, sway bracing bolted to sway piles and knee bracing. The remaining bents have diagonal bracing only.

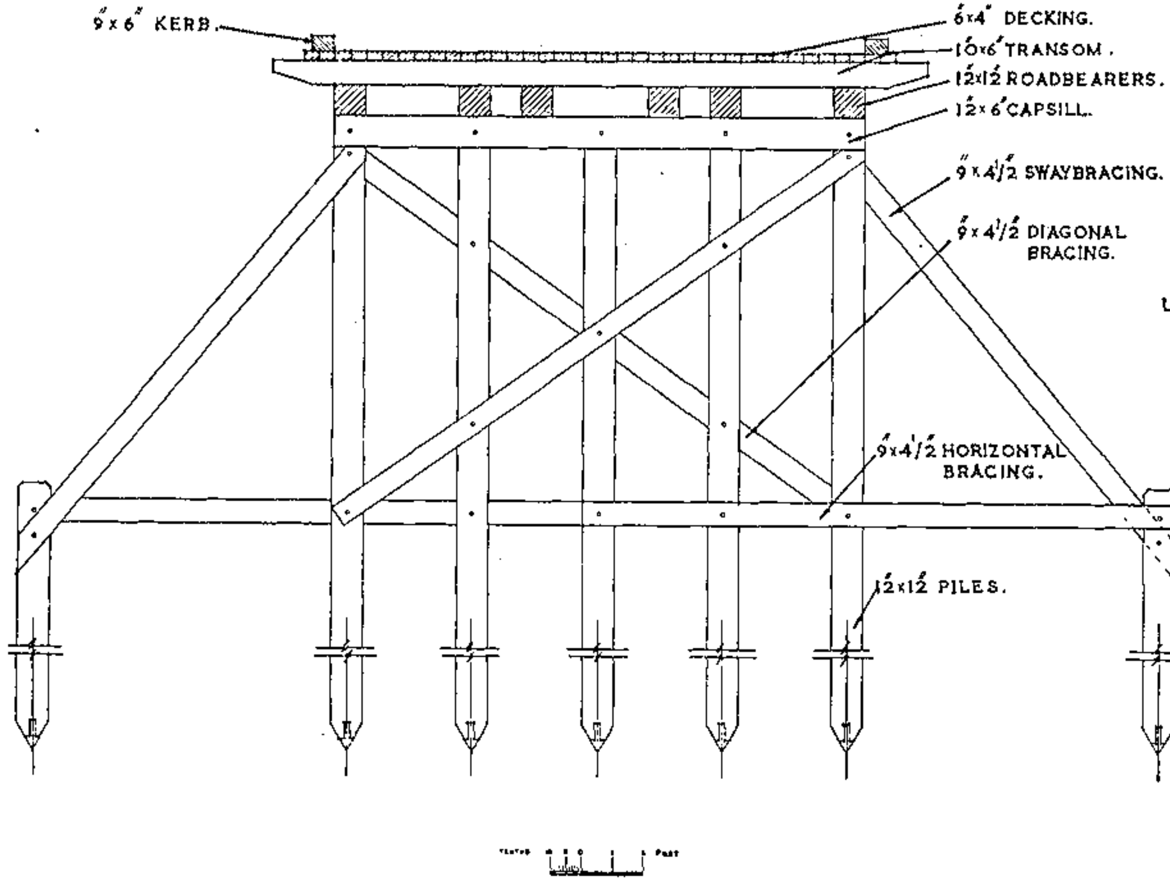
Construction Plan

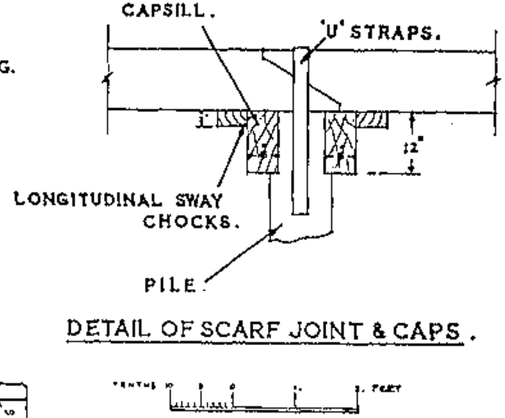
The road trace was cut up to the Muar River by 28th March, 1955, but a lot of clearing close to the river had still to be done. A large site for storing timber and cutting and joining piles was cleared using bulldozers and explosive. One notable tree, whose girth must have been over fifty feet, was felled by using 60 lb. of plastic explosive buried around the tree in 10-lb. charges. This tree was on the centre line of the bridge and its root system was later on to cause trouble for the pile-driving.

The construction plan was complicated by three main factors:—

(*a*) For operational reasons the bridge had to be open to traffic as soon as possible.

FIG. 2.





DETAIL OF SCARF JOINT & CAPS.

(*b*) The north bank of the river was not yet accessible from Rompin.

(*c*) As it was impossible to use a floating rig the pile-driver would have to be on the bridge in order to drive piles into the river.

The solution adopted was to build an earth ramp on the south bank, pile the first water bent from this earth ramp and then temporarily deck across from the ramp to the bent. The pile-driver would then be able to move up to the first bent and drive the second water bent. In this way, alternately decking and driving, the river could be crossed without first driving the land bents on the south side. When the river had been crossed the temporary bridge could be opened for traffic using the ramp as a way on to and off the bridge while the remaining bents on the south side were driven.

The earth ramp was to be 17 ft. above ground level, its front edge level with the river bank. To retain the fill vertically a timber pile retaining wall of 30 ft. jungle timber piles of 15 in. diameter was to be built. The revetment was to be 4 in. round jungle timber. All this timber was available in the jungle close to the site.

Building the Ramp

A start was made on this plan on 5th April, 1955. A borrow pit was found close to the site and fill was brought in using a Size II tractor and 6 cu. yd. scraper. At the same time the retaining piles were driven and proved excellent practice for the later bridge piling. Building up continued well, although hampered by heavy rain, until the ramp had reached about ten feet above ground level. Then an alarming sag forward was seen in the front of the retaining wall. One retaining pile had also cracked and it was obvious that the retaining wall would fail if more earth were placed behind it (see Photo 1). The idea of driving the first water bent from the ramp was therefore abandoned. Work was stopped on it, a retaining S.W.R. being passed round the piles to prevent any further sag forward. The ramp was now considered merely as a method of getting the pile, driver on to a completed bay of bridge. By driving bents 8 and 9, decking them and then getting the pile-driver on to the bay via a temporary timber crib, piling out into the water could be started.

Pile Driving

To drive bents 8 and 9 into the ramp it had first to be extended horizontally so that the pile-driver could manœuvre on it. While a bulldozer was making the extension, work was started on bent 2. (Bent 1 was an afterthought by the designer, added to the plan later on.) The driving of bent 2, the first square piles to be driven on the site, taught many lessons. The pile driver was positioned so that its tracks were parallel to the line of bridge. The 25 ft. long piles were attached to the pile leaders by two ¾-in. bolts positioned 5 ft.

and 15 ft. from the top of the pile. To lift the pile into position an S.W.R. sling was used, passed over a ¾-in. bolt fitted 2 ft. from the pile top. Photo 2 shows bent 2 being driven with the pile driver tracks parallel to the bridge.

It was very soon clear that the following errors were being made:—

(*a*) With the pile-driver tracks parallel to the line of bridge the pile-driver had to be manoeuvred into a fresh position for each pile. This involved slewing the tracks, causing deep rutting in the soft ground, and consequent sinking of the tracks.

(*b*) The bolts holding the pile to the leaders were tightened too much and this fact combined with the very thick tar on the piles led to the pile sticking on the leaders.

(*c*) Tree roots below the surface caused the piles to deflect.

(*d*) Bad fitting of rings to pile heads caused splits in the pile.

(*e*) The ¾-in. bolts used for lifting piles were not strong enough especially when a pile, having been driven two or three feet, had to be withdrawn because it had gone in crooked.

By experience it was found that the best method of driving was:—

(*a*) The pile driver worked across the line of bridge. This eliminated slewing of tracks.

(*b*) The pile driver ran on timber grillage which had been levelled. This eliminated sinking of tracks and ensured truly vertical leaders. The importance of level grillage for the pile driver must be stressed. Had it not been used the frequent heavy rain and consequent soft ground would have bogged down the pile driver.

(*c*) A small trench was dug to clear roots and large stones in the pile positions. The trench was also useful when 30-ft. piles were being driven as the clearance between normal ground level and the hammer was not sufficient for such a long-pile.

(*d*) The tar was diluted with diesel oil before being applied, the pile leaders were cleaned and greased and the pile retaining bolts kept fairly loose.

(*e*) Particular attention was paid to ensuring that pile rings were seated squarely on the pile and that the whole of the bottom surface of the ring was in contact with the pile.

(*f*) 1-in. bolts were used for lifting piles.

Having learned these lessons bents 3, 4, 5, 6 were driven without further trouble. The best day's work in this phase was the driving of four piles in bent 5.

Piling Delays

The first priority, that of building one bay (between bents 8 and 9) on top of the ramp, was carried on as quickly as possible, but unfortunately there were many setbacks.

Pile 2 in bent 9 on the ramp was driven to 34 ft. 6 in. although the set obtained at this depth was no better than 0.4 in. per blow. As the specification demanded 0.28 in. set per blow (which on bents

Photo 1. Retaining wall on south bank seen from the north bank. The cracked pile can be seen on the right of the picture. The restraining cable passes over a back baulk of timber about two feet below the tops of the piles.

Photo 2. Pile driving in Bent 2. The pile driver tracks are parallel to the line of bridge A bent lifting bolt can be seen at the top of the left-hand pile.

Gurkha Bridge 1,2.

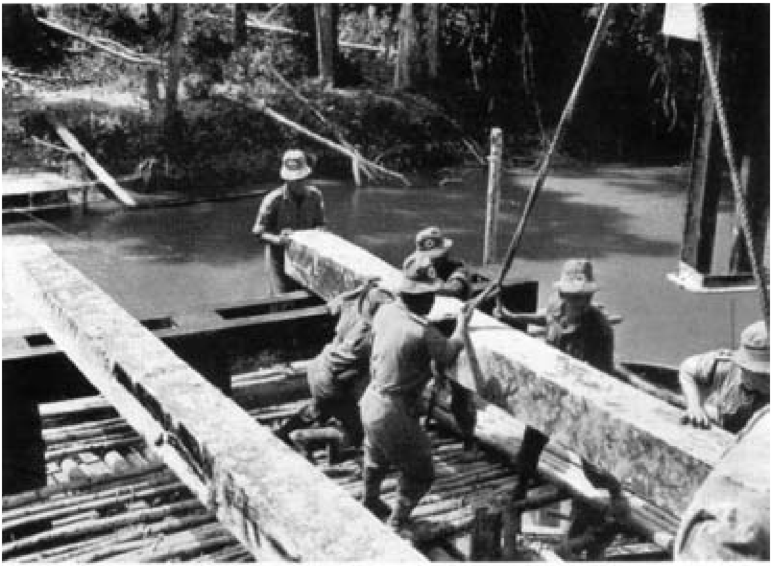


Photo 3. Placing a roadbearer. The pile driver is being used to lift the road bearer.

Photo 4. A pile in Bent 16, having been placed, is being adjusted prior to driving. In the background a 19 R.B. crane is working in the stores site.

Gurkha Bridge 3,4

2, 3, 4, 5, 6 had normally been obtained at 18 ft.–20 ft. penetration) work was suspended on bent 9 until a decision from P.W.D. was obtained. Pile 1, bent 8, and pile 2, bent 10, were driven to 38 ft. 9 in. and 37 ft. respectively, but 0.28 in. set was then obtained.

As the longest pile available was 30 ft. long it was necessary to splice together using fish plates and bolts. Drilling the holes for the splice bolts caused much trouble. At first it was assumed that a precision drilling jig would have to be used. Such a jig was made but proved useless. When drilling from one side only no more than ⅛ in. movement from line could be tolerated. But the drills would not run straight in the very hard timber and deviated ½ in. or more.

Eventually the method adopted was the one which at first sight seemed least likely to succeed. The drilling was done from each side just over halfway through. The resulting hole was hardly ever straight, but a bolt driven by a sledge-hammer bent obligingly and generally came out the other side without burring the threads.

Drilling splice joints on the south bank bents had to be done after the lower pile had been driven. This involved using a drill between piles. As the distance between piles was only 3 ft. a drill of not more than 15 in. could be used (the drilling machine, even with its handle removed, measured 1 ft. 9 in.). Drills of such a short length were not available from W.D. sources. They had to be manufactured by cutting down a normal ¾ in. compressor drill and brazing on a shank. The first such drills made in 305 E.S.D. proved unsatisfactory, breaking off at the shank. A rather more sturdy type was made, but neither type was really satisfactory. The lack of short drills could well have been a reason for a complete stoppage of work. The few short drills obtained from civil sources long outlasted the improvised models.

Water Bents

Driving of piles in bents 8 and 9 was completed at last and capsills, road bearers, transoms and temporary decking put on. A timber crib covered with earth was built by the east side of the bay and the pile-driver was driven up it. A D7 stood by to winch the pile-driver but was not used. The bay had been strengthened with packing and 9 in. jungle timber had been laid alongside the road bearers. Bent 10 was then driven.

The distance from deck level to the river varied from 28 ft. to 22 ft. This made it impossible to drive a 25-ft. long pile from the bridge, because, when the pile had been placed in the water, at the best its top would have been only a few feet up the leaders and at the worst several feet below the leaders. Two methods of overcoming this were tried:—

Method I. A 20 ft. long 12-in. "dolly" was bolted on to a 25-ft. pile using one or two bolts and two splice plates. This composite pile was then driven as far as possible, i.e., until the top of the dolly reached the end of the leaders. The dolly was then removed, another 25-ft. pile permanently bolted on and driving continued until a 0.28-in. set was obtained. One bent (No. 11) was piled in this way, but the method proved unsatisfactory for the following reasons:—

(*a*) The temporary joint holding the dolly to the lower pile tended to buckle. This could have been prevented had more bolts been used, but withdrawing even the two bolts used took a long time.

(*b*) The joining of the top pile to the bottom one had to be done from scaffolding—a difficult job and expensive of time because the 19 R.B. had to hold the top section whilst the drilling of the joint was being done. This job might take only twenty minutes, but sometimes took a whole hour.

Method II. The piles were joined horizontally in the bridging store. This was much easier than working in a vertical plane from a scaffolding. Piles were cut in pairs; one having a point and a half joint, the other a ring and a half joint. The two half joints were then placed together using a 19 R.B. crane. Bolt holes were drilled and splice plates fitted. The drill worked in a vertical plane and drilling was very much faster. Production of piles just about kept pace with driving, but this rate of production was not entirely dependent on carpenter's work as the supply of new piles from the sawmill tended to be erratic.

So that these heavy piles (about 1 ton) could be lifted without overturning the pile-driver it was necessary first to remove the piling hammer. The pile was then lifted and its point placed in the correct position on the river bed. Three vehicle winch ropes held it vertical whilst the pile-lifting sling was released from the pile, the hammer quickly picked up, and the pile bolted to the leaders. This method proved quick enough to drive three and a-half piles in one day. There were no snags, but care was obviously necessary in guying the pile. The winch ropes were placed at approximately 120° to each other as high up the pile as possible and tightening was done in stages. Once the hammer had been replaced the pile could not be lifted because the machine would inevitably overturn and, therefore, the initial placing of the pile had to be done very carefully.

As can be seen from the bridge plan it was impossible to drive piles 1 and 5 with the pile leaders square to the line of bridge, because in this position one track of the 19 R.B. would have had to have been supported on thin air. At first it was thought that a pile rig having rotating leaders must be used, but such a rig was not immediately available. However, a small steel wedge placed between the pile and the leaders proved satisfactory. Later on, as more experience was gained the wedges and bolts were dispensed with and the pile held to the leaders by a small lashing. The pile was kept square by winching, using vehicle winches applied to form a turning couple.

The North Bank

For various reasons a second pile-driver was not immediately available, although the road from Rompin to the river had been cleared. By the time a second machine was available and had reached the north bank—it had to make a journey of seventy miles, the last six on its own tracks, to get there—only three pile bents remained to be driven.

The north bank, which was very steep, was prepared by cutting level benches across it using a P.W.D. angledozer. This machine, an Alliss-Chalmers H.D. 20, was the first Torque Converter tractor seen by many of the squadron and an impressive sight it was as it pushed down a "jungle giant" about 150 ft. tall. Having cut level benches, pile driving was very easy and it was possible to drive five 25-ft. piles in one day. The cutting of benches cleared all surface roots and exposed a firm bed of laterite which gave the pile driver an excellent surface to work on.

When the three north bents had been driven the pile driving was virtually complete, only the bracing piles remaining to be driven. For these a "dolly" was essential, as the bracing piles were only 20 ft. long. The dolly was a 25-ft. pile having a pile ring at one end and a box made of four splice plates at the other. The bracing pile was first lowered into position and held by winches; the dolly was then placed over the pile so that the pile head was contained in the four splice plates.

Re-Aligning Bents

Although great care was taken in pile-driving, for various reasons the driven piles were not in line. Theoretically it should be possible to drive piles in perfect alignment. In practice, without spending an unwarranted amount of time, such perfection cannot be obtained. Some reasons for this are:—

(*a*) The piles are generally not straight.

(*b*) Underground roots and rocks deflect the piles.

(*c*) After the pile has reached a depth of about ten feet it is very difficult to winch it vertical.

To fit capsills the piles had first to be re-aligned. Pull Lift jacks were used, the piles being winched to a mean line. This meant that at the most three piles had to be pulled in to meet the line joining the remaining two. The ease with which re-alignment was done made it evident that too much time should not be wasted in attempting to drive the piles in perfect alignment. Errors of an inch or two caused much gloom during driving, but were correced by the Pull Lifts in a few minutes. Of course the average length of pile above ground was over twenty feet which made winching into line fairly simple. With shorter piles more care would be necessary during driving.

Estimating for Piling

It is very difficult to make a correct estimate of the time it will take to drive piles. Table 1 gives a week-by-week summary of the progress of pile driving. A total of 116 piles were driven in 112 days which gives a very rough overall average of one pile per day. So many factors have to be taken into consideration that it is safer on a bridge of this type to estimate progress as so many days per bay of bridge. At six days per bay the bridge would have taken 114 days, which corresponds fairly well with the figure of one pile per day, assuming six piles per bay. There were actually seven piles per bay, but two of them were sway piles which together would amount to one main pile for driving purposes.

Allocation of Men and Plant

Table 2 shows the week-by-week allocation of men and plant to the job. In the later stages of the job the working numbers might on any day be distributed thus:—

In stores site preparing piles	8
Driving piles	12
Cutting roadbearers	8
Moving stores	8
Workshops	3
Sentries	6
Patrols	7
Erecting scaffolding	8
Total	60

At first only one 19 R.B. was available and as this was permanently employed on pile-driving a lot of heavy lifting in the stores site had to be done by hand. A second 19 R.B. rigged as a crane arrived in May and its use released a section of men which had been employed manhandling stores for jointing piles.

Gurkha Tradesmen

The point of view is often expressed that "Gurkhas are fine soldiers but will never make Sappers". The construction of Muar Bridge should help to show how false this statement is.

All carpenters' work was supervised and controlled by two Gurkha Corporals. Whilst the standard of carpentry required on piles is not very high the work certainly could not be done by a non-tradesman. Tasks included the fitting of pile rings and pile shoes, the splicing of piles, the scarf jointing of roadbearers and the production of the hand rail. Considering that the carpenters had not been employed on work of this kind before the work was well done and standards improved noticeably over the months.

A small workshop was also run; its staff being a blacksmith, a plumber and pipefitter, and a welder. A number of small repair jobs were done but the main task was the straightening and re-threading of $\frac{3}{4}$-in. and 1-in. bolts used on the bridge. Many of these were bent, during the lifting of piles or when used to hold a "dolly" on to a pile. All these bent bolts were repaired and used again.

Conclusion

Muar Bridge, the first big timber bridge built by Gurkha Sappers, showed that Gurkhas can cope with Engineer tasks in an efficient and workmanlike way. The Gurkha Officers and N.C.Os. made great progress and towards the end it was quite possible to give a corporal a spirit level and tell him to supervise the driving of a pile. But it must not be forgotten that without the British operators of the pile-drivers the bridge could never have been built. Some day soon there will be Gurkha excavator operators, but until then we shall have to rely on the very willing and efficient work of the British plant operators. They stuck to their job with great perseverance.

The bridge was formally opened on 6th September, 1955, by the G.O.C. 17 Gurkha Division, Major-General R. N. Anderson, C.B.E., D.S.O., who named it "Gurkha Bridge"—a fitting tribute to the work done by the Gurkha Engineers during their first year of operational service in Malaya.

Appendix A

Table 1

Serial	*Week Ending*	*No. of Piles Driven*	*Running Total*	*Remarks*
1	30th April	8	8	
2	7th May	11	19	
3	14th May	6	25	Deep penetration slowed work
4	21st May	5	30	Broken drills slowed work
5	28th May	4	34	Broken drills and compressor slowed work
6	4th June	1	35	Building ramp and decking down one bay to get pile-driver on to bridge
7	11th June	—	35	
8	18th June	8	43	
9	25th June	5	48	
10	2nd July	7	55	
11	9th July	6	61	
12	16th July	9	70	
13	23rd July	6	76	
14	30th July	19	95	Two pile-drivers working
15	6th August	—	95	
16	13th August	5	100	Eleven sway piles also driven this week

Appendix B

Table 2

Serial	*Week Ending*	*Av. No. of Men*	*Days Worked*	*Plant*	*Plant hrs. Worked*	*Remarks*
1	9th April	15	5	1×TD 18	30	Dozer and scraper used to build up ramp
2	16th August	15	6	1×TD 18	24	
3	23rd April	30	6	1×TD 18	18	
4	30th April	25	6	1×19 RB	36	
5	7th May	30	6	1×19 RB	30	
6	14th May	30	6	1×19 RB	30	
7	21st May	18	6	1×19 RB 1×19 RB	30 30	Extra 19 RB permanently employed in stores site
8	28th May	40	4	1×19 RB 1×19 RB	30 24	
9	4th June	40	6	1×19 RB 1×19 RB	36 36	
10	11th June	50	5	1×19 RB 1×19 RB	30 30	
11	18th June	60	6	1×19 RB 1×19 RB	30 30	
12	25th June	60	6	1×19 RB 1×19 RB	30 30	
13	2nd July	50	5	1×19 RB 1×19 RB	24 24	
14	9th July	50	6	1×19 RB 1×19 RB	30 30	
15	16th July	50	6	1×19 RB 1×19 RB	25 25	
16	23rd July	50	6	1×19 RB 1×19 RB	30 30	
17	30th July	40	5	1×19 RB 1×19 RB 1×19 RB	25 25 25	Third 19 RB commenced pile-driving on North bank
18	6th August	50	5	1×19 RB 1×19 RB 1×19 RB	20 20 20	
19	13th August	60	6	1×19 RB 1×19 RB 1×19 RB	25 20 10	
20	20th August	60	6	1×19 RB 1×19 RB 1×19 RB	15 15 10	
21	27th August	60	6	1×19 RB 1×19 RB 1×19 RB	15 15 10	

APPRECIATION OF THE SITUATION

By MAJOR J. I. PURSER, R.E.

"AS Comd X Inf Bde, give your appreciation of the situation." As often as not when confronted by these horrible words at the end of an exam paper, the mind becomes a blank—at least mine does, if only momentarily—and in desperation we read the whole question through again to see if we can make any better sense of it.

A great many people fight shy of appreciations and I believe the reason is that they are frightened off them in their youth. I can recollect my own impressions on first "meeting" appreciations in the syllabus of my early military training. They can be summed up in two words: bewilderment and incomprehension. One had to have things called factors—the dictionary said that these were facts or circumstances leading to a result, which didn't help much—from which one had to make deductions. But the sort of factors one was supposed to use like ground, time and space and relative strengths never seemed to lend themselves to the making of useful deductions. I used to end up with statements like surprise is essential or the enemy outnumber us—statements which were glimpses of the obvious. And then, after messing about with these, one was invited to list the courses open both to the enemy and oneself and choose one of them. Cynics who "knew the form" would say you wanted to think up your course first and then write your appreciation afterwards to prove it (and in a sense they are right as I hope we shall see later). However, the upshot of it all was that I regarded appreciations for a long time to come as a mystery and a burden, things to be avoided at all costs. Which is a pity really, because when all is said and done, there are few things more important, both in everyday and military life, than to be able to reason out a problem and decide on a sound and practical course of action.

There are, of course, some people whose brains work at the speed of light and who can solve a problem in a flash. They can write their appreciation down clearly and quickly to the satisfaction of less brainy people like me. My brain works at about the speed of sound—in fact, unkind people say they can hear it on these occasions—and I have to grapple with problems with the aid of lots of nearly illegible scribblings on rough pieces of paper before I can even start to convince anyone else of the soundness of my solution.

The Army in its wisdom has recently placed me in the position of having to unfold the mysteries of appreciations to others of lesser rank. I was not surprised to find that most of my pupils regarded appreciations in the same light as I did when I was in their position. It irritated me, however, that I was unable to be any more successful than my predecessors and I therefore set about trying to evolve some better method of teaching this reasoning process—which after all is what an appreciation is. It is in the hope that my ideas may help other fellow sufferers, even if it only leads them to evolving their own method of tackling the problem, that the following is written.

The Basic Principle

The first thing to grasp, I believe, is that a written appreciation is divided into two quite clearly divided parts: first, the thought process; secondly, the writing process. By this I don't just mean that one must think before one writes. The thought process, the first part, is the most important. In this we analyse the problem, decide what we have to do and then work out how we're going to do it; and as we have to solve far more problems for ourselves than we have to write down for others to see, this is where the process usually ends. But on the staff, or in an exam, we have to be able to convince others of the soundness of our plan and the reasoning that led to it, so we can't ignore the writing half of the problem.

Nobody ever told me this and I always imagined that it was the act of writing an appreciation which solved the problem. To my mind nothing could be farther from the truth. You cannot, by simply writing down factors and making deductions, solve a problem and it's a waste of time trying to. The whole point of writing the appreciation is to present the problem and its solution in a clearly and easily understandable form for someone else to follow. Admittedly, in so doing it makes quite sure that our own ideas haven't been woolly; but that is not its main purpose. Herein, of course, lies the truth in the cynic's remark that you first decide your course and then write your appreciation. Where those who preach this doctrine often go wrong is in deciding on their course of action without sufficient thought and then "cooking" their appreciation so as to suit their plan by omitting awkward factors. This may be all right for the politician but it won't do for the soldier.

For exam purposes these two parts which I call the thought and writing processes are about equal, though if anything the thinking may take the longer of the two. The thought process should get us at least as far as listing all the possible courses—that is, if there is more than one course. We may find it easier to select our final course after we have written the appreciation because the act of writing forces us to marshal our arguments clearly and concisely. The writing of the plan, once the course is decided upon, I include in the writing process since relatively little thought should be required for this.

The Thought Process

Now how are we going to set about this thought process? It is something few of us were taught at school where we did a lot of learning and memorizing. They say that geometry and Latin taught one to think; but I don't recall being taught to reason things out logically except indirectly or incidentally. Having thereby admitted my complete lack of any qualification for attempting to teach others how to think, the reader is at perfect liberty to stop here and turn to some more erudite article—if he hasn't done so already. However, it may be of interest, if only to pass the time of day, to see how someone else tries to reason out a problem.

I like to pose my problems in the form of simple practical questions which avoid the abstract. Appreciations are essentially practical. Words like "Aim", "Ground", "Time and Space" are abstract and do not help one to think constructively. In place of these I prefer to ask myself questions such as "What have I got to do?"; "What are the possible approaches?"; "What obstacles are there in the way?"; "When can I start?"; "When must I complete my task?", etc. I feel there is more chance of getting a practical answer by asking questions like these than if one couches them in an abstract way like "What are the time and space considerations?"

The Aim

The first question naturally to ask is "What have I got to do?" (The Aim.) The only point I feel worth making here is to beware of tying oneself down too soon with all sorts of limitations. We must answer this question without too much delay and the hasty and ill-considered imposition of limitations on our aim right at the start may lead us off on a false scent. Any limitations there are will soon become apparent in the main thought process.

Breakdown of the Problem

Having established quite clearly what we have to do, the next most useful step is to see if we cannot break the problem down into phases or parts. Nearly every problem can be broken down in some way or other. There is no fixed rule: the breakdown may be by time, by place, by type of operation or by something quite different. For example, if our problem is to burgle a house, one obvious way of breaking the problem down is by phases: entry, operations in the house and escape. They are not entirely separate, of course—each may affect the other in some way—but one has now got three smaller and clear-cut problems to deal with, on which one can concentrate one's mind in turn. As I have indicated, it does not matter how the breakdown is made so long as it resolves the main problem into a number of simpler ones which can be considered in turn.

How, When, and Where

Now to the solving of these various sub-divisions of the main problem. My method is based on the fact that the framework of any plan can be given by the anser to the three general questions:

How am I going to do it?
Where am I going to do it?
When am I going to do it?

Where and when are self-explanatory. The How question admittedly covers a bigger variety of things, such as the number of men, their organization and tasks, type of weapons; but still it helps to channel one's thoughts. Moreover, these questions can be applied not only to the whole problem but to parts. Thus, in an attack, if part of the answer to "How?" is that one needs fire support, one wants in turn to know how this support is to be given (i.e., type of gun and shell), where it is to be given and when.

I, therefore, ask myself questions under these three main headings of how, when and where. These are, of course, only main headings; I do not mean to imply that every question will begin with a how, where, or when but the questions will fall into these groups. Having asked the question, there is immediately in each case the further question of "Why?" to be answered, to provide us with the reasons for adopting or ruling out any particular method, place or time. This is answered by the various relevant facts and circumstances surrounding the problem and any conclusions one has drawn previously.

It is not easy to describe a thought process. For a start, one thinks so much more rapidly than one can speak or write that it would be tedious in the extreme to set the whole thing down on paper. And if one tries to take a particular example, one is up against the difficulty of having to produce a detailed hypothetical problem which would be very wearisome to read and would in any case only show one way of thinking out a problem. No two people will ever follow the same *train of thought*, even though at the end they reach the same conclusion and for the same main reasons. However, I will try to illustrate this self-questioning process by taking the first phase of our burglary example already mentioned—the entry to the house. The reader must remember that it is only *one* possible line of thought and that I am not concerned so much with trying to solve a particular problem as showing *how* to solve it.

The first question is how to get in? (Notice that even this can be sub divided into the actual entry into the house and the approach to that entry. Let us take the actual entry.) What are the ways of getting in? There are a front door, say, a back door and windows on ground and first floors. Are the doors locked? Yes. Have I got a key? No. Are any of the windows open? Not on the ground floor but several on the first floor. Is there any means of gaining the first floor windows? No; no ladders or convenient drainpipes, etc. Can I break or force a lock quietly? No, I have no special tools. It looks, therefore, as if breaking a pane of glass in one of the windows will be the easiest means of entry (assuming we are not prepared to ring the doorbell and slug the occupant of the house when he opens the door), but that we will be unable to make a completely silent entry.

In this very short extract from a hypothetical reasoning process, several obvious practical factors have been taken into account, like the absence of a key and no windows being open on the ground floor. It is clearly easier to break a pane of glass than it is to break a door. So far so good, but now we meet a more intangible factor like noise. How important is it to be silent or not? If silence is vital then we may have to go back and insist on having special equipment. But if there's no one in the house and we can be sure that there are no policemen or bystanders around, then noise does not matter within reason. But it leads one to consider the question of *when* to break in (information on occupants' movements and policeman's beat automatically become factors) and *where* to break in (proximity to street lamps, road or other houses may provide part of the answer).

Factors

As I said earlier, I am not here trying to solve this problem; I am trying to illustrate a general method based on self-questioning. One of the reasons why I advocate this method is that I believe that in nine cases out of ten the relevant factors are automatically considered; or, put another way, the factors which one naturally considers in trying to answer these simple practical questions are bound to be relevant. Whereas, if one starts off with the question: "What are the factors?", it is extremely difficult to pick out the relevant ones and even more difficult to make useful deductions since one is not really clear in one's mind what one is trying to do. *Ground, Time and Space, Surprise* and other well-known headings don't help a lot. They may prove all right in an exam paper where one knows that all the factors must be in the text somewhere, even though some may be deliberate red herrings. But in real life the possible factors are infinite. Where does one start? Moreover, the "What are the factors" cry often leads to an unnecessary amount of work since many factors are considered which are irrelevant or, if relevant to a particular part of the problem, are considered in the wrong context and hence produce no useful deduction.

I do not pretend that this self-questioning process is infallible. Every now and again one should pause to ask oneself whether any vital factors have been overlooked because the omission of a seemingly trivial one may lead eventually to the adoption of a completely false course. There is, unfortunately, no rule about what factors one must consider. One can only gain this by experience. But there is one factor to which I think insufficient importance is attached and that is the enemy—his strength, capabilities, habits and intentions, etc. The enemy appears as a factor at nearly every turn. What he will or will not do, or is likely or not to do, will affect the plan enormously and must be considered during the appreciation. It is no good leaving to the end a consideration of the courses open to the enemy. The only time this paragraph should be used at the end of the appreciation is when there are two or more courses open to the enemy and we can only make a *guess* as to which he will adopt. This then highlights the fact that our assessment of the enemy's reaction is only a guess and that the soundness of our plan depends on whether our guess is right or wrong. If we can reason out what he will do, then this should be reasoned out in the appreciation.

The Choice of Course

We will probably be lucky if all the answers to our questions point to the adoption of one course but, if so, our work is done. It is more likely that factors will conflict and that we shall be left with more than one reasonable course, in which case we must draw up the pros and cons of each in the form of a sort of balance sheet. The first time we do this we may well think of some fresh question to ask or new factor to consider, not tremendously important in itself but sufficient to tip the scales one way or the other. Alternatively, our balance sheet may reveal the importance of some of the points already considered and lead us to re-examine them to see whether we have not missed anything vital. This re-appreciation may enable us to reduce the number of possible courses. Having done this, we are now in a position to write our appreciation.

The Writing Process

The aim of the writing process, as I said earlier, is primarily to convince someone else that our solution to the problem is the best. But we must be honest and not "cook" the facts. If there is a choice of possible courses (which is tantamount to saying that one is practically as good as the other), then we must state our reasons for choosing one in preference to another. The reader is then at liberty to agree or disagree with our choice (based on his experience). But he should not be able to pick holes in our reasoning process.

What we write down may appear very different from our original thought process. After all, we don't want to weary the reader with *all* the possible blind alleys we've chased up and with *all* the reasons why we found them no good. A few good reasons (factors) are quite enough. We must be clear and brief. Therefore, we should try and arrange the sequence of our appreciation so that we rule out step by step certain courses which at first sight seem possible. Besides being easier to follow this saves a lot of time and paper since we will not have to consider the factors in relation to a large number of possible courses. Our aim should be to narrow down the possible courses until, if possible, we are only left with one. We should use headings that mean something. "Approaches to the objective" (where applicable) is much better than "Ground"; the latter is meaningless. So is "Time and Space". Is it not better to use headings like "Best Time for Operation", "Times for Movement by Possible Routes", which mean something? They give the reader some idea of what one is trying to get at (not to mention the fact that they also help to remind the writer what *he* is trying to get at).

Summary

The points that I have made can be summarized as follows:—

(*a*) A written appreciation consists of two distinct parts: the thought process and the writing process.

(*b*) The thought process is the most important. Its aim is to solve the problem or at least arrive at the smallest number of reasonable solutions. (The problem is not *solved* by writing an appreciation.)

(*c*) The first step after deciding what it is one has to do is to break the problem down into separate smaller problems, on which one can concentrate one's mind in turn.

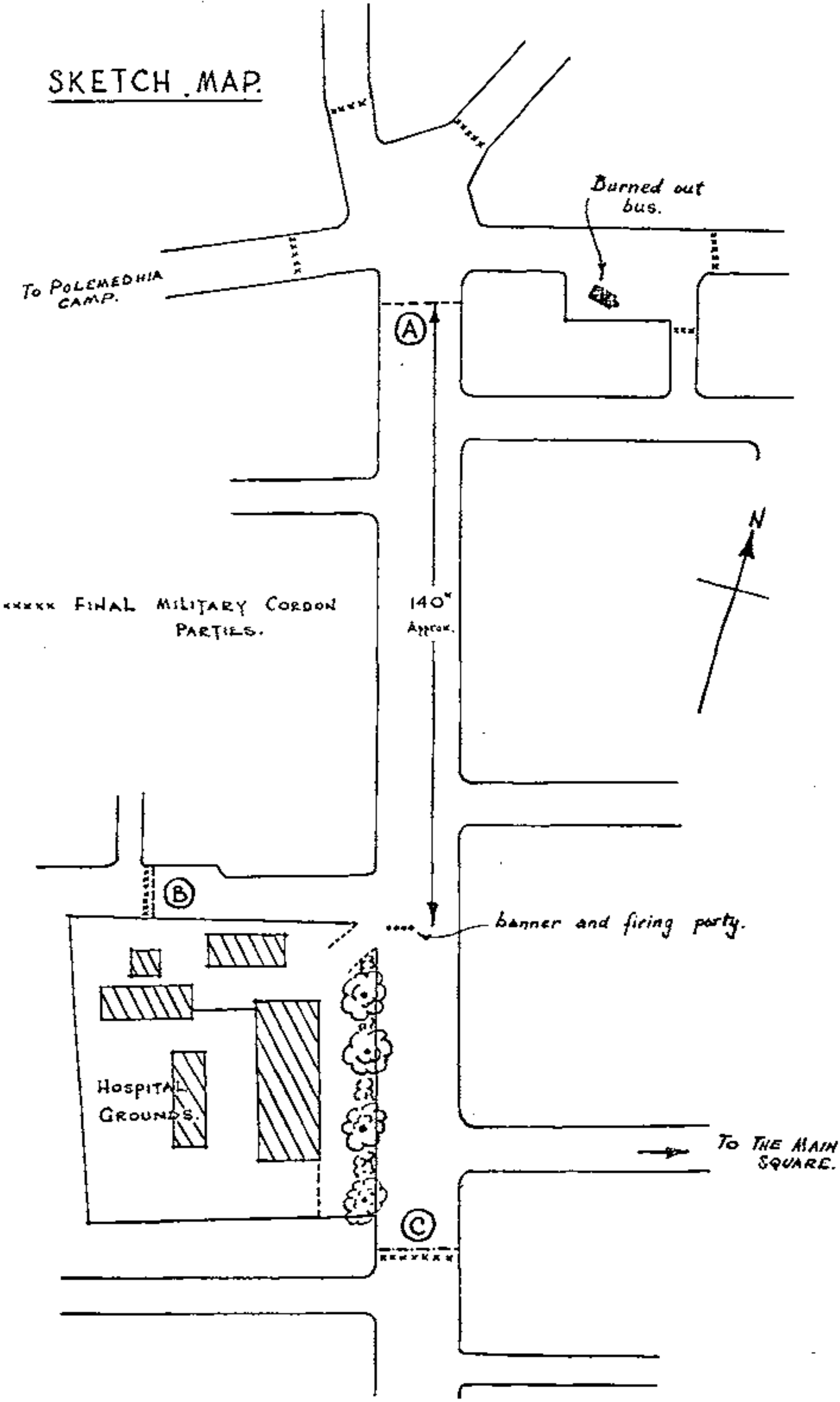
(*d*) To each of these smaller problems keep asking questions under the headings How, Where, and When, followed in each case by Why, which will usually lead one to consider automatically the relevant factors.

(*e*) Do not start off by asking what are the factors; this leads nowhere. But now and again ask oneself if there are any factors one has overlooked and remember the importance of the enemy as a factor the whole time—not right at the end.

(*f*) The aim of the writing process is to convince someone else that our solution is the best (but there must be no "cooking" of factors).

(*g*) The written appreciation must be clear and brief. Try to rule out possible courses step by step and use headings that mean something.

I make no claim for having said anything original or novel, nor do I imagine for a moment that my ideas will find approval all round. On the other hand, they may shed a ray of light into the darkness that seems for so many officers to surround the subject of appreciations and they may encourage the thought that an appreciation is essentially practical (and not just a theoretical piece of mumbo-jumbo). Even if this article only helps others to evolve for themselves a more satisfactory reasoning process, I shall feel that something has been achieved.


SKETCH MAP.
Burned out bus.
To POLEMEDHIA CAMP.
A
xxxxx FINAL MILITARY CORDON PARTIES.
140x Approx.
N
B
banner and firing party.
HOSPITAL GROUNDS.
To THE MAIN SQUARE.
C

IN AID OF THE CIVIL POWER

By Captain J. N. Elderkin, R.E.

Introduction

THIS is an account of how Sappers of a Field Squadron were called upon to act in aid of the civil power and subsequently to fire on a rioting mob. Fortunately such occasions have in the past been rare and most officers have depended on Gwynn's *Imperial Policing* and the official pamphlet for their ideas on such incidents. They may have been tempted to ask themselves how much of it still applied, and anyway, was not a lot of it rather theoretical? All those who were involved in this incident felt they had been given priceless experience; for that reason this tale is told.

Local Background

In December, 1954, few people in England knew much about Enosis. In Cyprus there had been murmurings and slogans but no terrorism of any kind. The Greek Government were trying to persuade the United Nations to discuss the Cyprus "problem", but outwardly it had no effect on the daily lives of the people in the island; both Greeks and Turks were always friendly. The Government were, however, well aware that trouble might come suddenly and plans had been made accordingly. Garrisons in the island had their internal security schemes and drills for emergencies had been worked out. In the Limassol district one Field Squadron had been earmarked for duty in the town and it had been agreed that it would move to the hospital grounds should the Commissioner consider it necessary (see Sketch Map); this area was chosen as being the closest to likely trouble spots. It was also arranged that at the same time R.H.Q. would send an officer with a wireless set to join the Police Superintendent and the Commissioner in the main police station.

Limassol is a thriving town of narrow streets and low two storey buildings. It has no real centre and no open spaces. A crowd could fade away through front doors and reform in the next street at the back. Of its 60,000 inhabitants about one-sixth are Turkish. At the time of this incident service families were in lodgings spread evenly over most of the town.

During December a certain amount of I.S. training was carried out, and officers familiarized themselves with key points in the town and explored routes through the maze of streets. The Field Park Squadron made up warning banners inscribed in Greek, Turkish and English, calling on crowds to disperse or risk being fired on; they also produced some knife rests and concertina wire.

The U.N. refusal to discuss Cyprus was made known on 17th December and island leaders at once called for a general strike on the following day, a Saturday. The Limassol Commissioner felt that there was no real likelihood of trouble occurring and no special steps were taken beyond issuing warning orders to the commanders of the two troops available (both National Service Officers),* and deciding on scales of ammunition, allotment of vehicles and so forth. Weekend leave was not entirely cancelled and even the S.S.M. was given a holiday! This is important because it does reveal the squadron outlook at the time. None of us had ever seen a hostile crowd.

18th December

At 0920 hrs. the Commissioner reported that several large parties of students were assembling and asked for the local security scheme to be put into operation. The Limassol Squadron was therefore placed at immediate readiness and at 1100 hrs. the Squadron Commander was told to move with his squadron to the hospital. About eighty men in seven or eight vehicles moved down from the camp without incident. The Regimental wireless net was opened and communications, although hampered by buildings, were tolerable all day. At about the same time the A/C.O. moved to the police station and the remaining two Field Squadrons were alerted.

The hospital was surrounded by a low brick wall with iron railings on top of it; nowhere was the wall more than thirty yards from the building. Inside the enclosure, trees and outbuildings gave a certain amount of cover and the vehicles were parked well clear of the entrance. In the road outside people were going about their normal business and one or two stopped to see what was going on. An officer was sent to the main square to find out what was happening there; he reported that someone was addressing quite a large crowd, but that there was no sign of rowdiness. It was now about 1145 hrs.

1200 *hrs.*

A crowd of fifty to sixty people had assembled outside the hospital. It was made up of cheerful friendly looking Cypriots and inquisitive children. From the Square there were occasional shouts of EEE-NO-SIS-EEE-NO-SIS.

1245 *hrs.*

A report was received that a British-owned bar not far from the hospital had been broken into by a mob. The Squadron Commander reported that he considered the police should act to disperse the crowd outside the hospital without further delay.

1310 *hrs.*

Police addressed the crowd, but they refused to move. They were reported to say that they would stay as long as the troops stayed.

*Second Lieutenants N. D. K. Wykes and A. N. Hale.

1330 *hrs.*

The crowd was now about 300 strong and were calling for the Union Jack on the hospital to be lowered. Shouting of EEE-NO-SIS and other slogans was almost continuous and when a vehicle from the camp arrived with the Squadron's lunch they all became very excited. The numbers were still increasing, and at this stage a knife rest was placed across the entrance to the compound and the Sappers concerned were the target for the first stones. The police again addressed the crowd with a loudspeaker, but to no avail, and the intensity of the stoning increased. The Squadron and its vehicles were showered with missiles, some of them rocks weighing three or four pounds lobbed like hand grenades. Vehicle windscreens were shattered and canopies torn. Some Sappers were struck, but none seriously.

1400 *hrs.*

The Commissioner sent his striking force of two police riot squads to the hospital. One was armed with rifles, the other with batons and shields and they had a small number of tear gas bombs between them. Their success was immediate and using the tear gas they drove the crowd away from the hospital and established cordons at the points marked A, B, and C on the Sketch Map. Some Sappers were caught without their respirators.

1415 *hrs.*

By this time the crowds had regrouped and were stoning the police cordons. The Field Squadron was deployed with one troop to the rear of the hospital and one to the front, both being readily available as striking forces. At the Command Post in the police station it was clear to the Commissioner and the A/C.O. that the situation was deteriorating and at about 1425 hrs. the command party reached the hospital. When they arrived the situation was as follows:—

(*a*) The armed police party was at "C" and although there was some stoning the situation was under control.

(*b*) At "B" a police baton party had a small crowd under control.

(*c*) At point "A" the situation looked rather ugly. The crowd was very large and extended into the roads radiating from the cross roads. The A/C.O. estimated that 500 people were visible. The twenty odd police, equipped only with batons and shields, were being stoned continuously.

A few minutes after he arrived the Commissioner asked the Superintendent of Police to relieve some of the rifle party at "C" with men from "B", and to reinforce "A" with the riflemen. However, before this could be carried out the police at "A" started to withdraw. The movement began in an orderly way, but ended in disorder. The mob, stoning heavily, followed at about fifty yards range. The police fell back to the hospital gateway where both they and the Squadron area were again in range of the rioters. At this point the Commissioner formally requested the A/C.O. to take over the situation; the request was verbal and confirmed shortly afterwards in writing; the time was 1440 hrs. This procedure was in complete accordance with official doctrine. (The Commissioner did in fact write his request on the back of a bill which is now in the R.E. Museum.)

The A/C.O. considered that the crowd could only be dispersed by fire. A banner was unfurled across the road and the crowd to the north were warned by the Police Superintendent that fire would be opened on them if they did not disperse. They were then massed in the road about fifty yards from the hospital entrance. An N.C.O. and three selected Sappers were formed up beneath the banner; magazines were charged, but the rifles were not cocked. The N.C.O. was then ordered to load and fire, but the round was obviously wildly aimed and went over the heads of the crowd without producing any noticeable reaction. The first Sapper was then given a similar order and this time, although no one in the crowd was seen to fall, the mob withdrew some yards and thinned. Stones were falling around the small party under the banner, and all were suffering from the effects of tear gas, masks having been removed in order to see more clearly.

At this stage the A/C.O. decided a further round was necessary and the N.C.O. was ordered to fire at a man in the front of the crowd, who besides wearing a distinctive shirt was also an active and accurate stone thrower. He fell. Almost magically the crowd scattered. Four of the mob carried the wounded man to the hospital entrance and troops assisted them to the casualty station.

The street was now almost clear. Sappers were formed up in line abreast and with fixed bayonets moved down the main road and the lane on the north side of the hospital. Side alleys were picketed and after reaching the cross-roads attention was turned to the small square to the east. Here a pillar of smoke seen earlier, turned out to be coming from a bus which the rioters had overturned and burned. The area had to be physically cleared and as no police were available the troops carried out the task; inevitably they came into close contact with the crowd and the sight of their fixed bayonets had a very sobering effect. Cordons were finally established at the points shown in the sketch.

By about 1515 hrs. crowds had collected in front of all the cordons, and although there was no stone throwing, they would not disperse. Any gap between the troops and the crowd was only preserved with the greatest difficulty. At 1530 hrs. a second Field Squadron arrived on foot and gave assistance by thickening the cordons and providing a reserve.

1615 *hrs.*

The mayor of Limassol (a Communist) and other leading citizens arrived at a cordon by car and asked to speak to the Commissioner. The Troop Commander marched the mayor up the street. The

Commissioner allowed the party to address the crowd over the police loudspeakers, and they made every effort to persuade the people to go home. Some of the older people seemed to take the advice, but it had no effect on the youths and children.

1720 *hrs.*

Dusk was falling and the Commissioner and the A/C.O. agreed that the troops should withdraw to the outskirts of the town. The crowds were told that the troops were going, but must not be followed. Sappers from the first Squadron were rapidly marched back to their vehicles in the compound, and the second Squadron marched out of the town in close order. The vehicles drove away under a shower of stones and the police who came behind them had a very hot time. In some ways the situation looked almost as bad as it had done four hours earlier, but the provocation was gone and it did not develop. When the Commissioner got back to the police station he agreed that the police should resume control; the troops remained at readiness.

Later on in the evening the police dealt energetically with groups of rioters roaming the town, but apart from broken windows in a British-owned hotel no serious damage was done; a heavy downpour finally cleared the streets at about 2100 hrs., to the considerable relief of the civil and military authorities.

Retrospect

Outbreaks of rioting occurred in other towns on the island the same day and it later became apparent that the disturbances were far from spontaneous. A mobile police column in Nicosia was originally intended to assist outlying towns, but was never allowed to leave the capital. Agitators in Limassol seized on the presence of the Army as a suitable focus and built up the riot round them. Police investigations later revealed that a mobile wing on bicycles had been used to explore the flanks of Army and police action and enabled the movements of the crowds to be effectively co-ordinated. There had also been an organized supply of stones to the rear of the crowd. The three shots fired caused three casualties in all; two were attributed to the second shot. No one died.

Troops in the Limassol area were never again allowed to become passive targets, and were later freed from the necessity of waiting for control to be formally handed to them before taking preventive action. As a result no major disturbance took place in Limassol during the next nine months; when one did occur, the same Squadron was brought quickly in from the outskirts of the town and was able to clear the streets by vigorous action without resorting to firing.

Tailpiece

A National Service Sapper, a plumber by trade, who was at the hospital on 18th December, was so disgusted at the comments made on the affair in a certain Sunday newspaper by a Labour M.P., that he wrote and told him so. A week later, in his column, the M.P. quoted from his letter—it read somewhat as follows : "I was there when the crowd were fired on. My commanding officer was quite right. He did the only possible thing." The Squadron was rather proud of him.

Conclusions

It is always much easier to be wise after an event and although some of the points made may be fundamental they bear repetition.

1. Once a situation has been allowed to develop in such a way as to make firing inevitable, a single round fired at a ring-leader does all that has ever been claimed for it. The fire order must be explicit and the shot aimed to kill.

2. Nowadays a spontaneous riot is a very rare thing. The opposition must be credited with making deductions as to probable police and military action; the riot is usually organized round a hard core trained for the purpose and it is against them that action must be directed. If they can be broken up, the passive crowd, however large, can be ignored.

3. Troops must never be allowed to stand about and become "Aunt Sallies"; transport must be kept right away from the scene of any disturbance.

4. A crowd is very sensitive to being surrounded, even when troops are thin on the ground; in a closely built-up area the aim should be to envelop it and restrict its movement. Troops should not be inserted into a crowd. If possible a bicycle curfew should be imposed.

5. If it is necessary to cordon a street there must be a physical barrier between the troops and the crowd. Concertina wire is ideal and should be combined with some form of "Do not cross sign". The official pamphlet recognizes the psychological value of fixed bayonets when troops have to be used to clear crowds, but often in I.S. training the importance of avoiding close contact with crowds is stressed to such an extent that the contingency is never catered for; this is a serious mistake because it will often be unavoidable.

6. Preparations for internal security action must include the making of ample numbers of warning signs and banners; any detachment may have to fire and one troop can well use six or eight at a time. Vehicles should carry XPM or similar frames which can quickly be fitted to protect windscreens.

7. Whenever civil disturbance is imminent and troops are alerted, liaison between civil and military authorities must be such that troops are used in good time, given a clear task and then withdrawn as soon as it is accomplished. In the circumstances just described almost the most difficult decision was when and how the troops should be disengaged. It must of course depend on the police strength and morale, but the longer the delay the harder it becomes.

RED PATCH

By THE LATE COLONEL A. C. MITCHELL, O.B.E.

Editor's Note. In the June and September, 1950, issues of the *R.E. Journal* we published an article entitled "C.R.E. Nobody's Sappers" giving an account of the 7th Armoured Division Engineers up to the time of their capture by General Rommel's Afrika Korps in April, 1941.

Colonel Mitchell died in December, 1951, and amongst his papers were accounts of his time as a prisoner in Italian hands.

The article published below covers the first part of this period and it is hoped that it may be possible to continue his story later.

PRISONERS' TREK

WE had been outnumbered from the start and had withdrawn 300 miles in ten days, losing many of our vehicles through bombing and the rough going. All our artillery and most of our armour had gone and we were left with one rather groggy tank. Entirely surrounded, we tried to break through the ring; but it was in vain, and after an hour's mad rodeo in the dust we were forced to surrender. Enemy appeared from everywhere, in tanks, lorries and on foot. Prisoners were formed up in a crowd, marched off a short distance from their vehicles and there halted, ringed round by guards. A British aircraft, mistaking us for the enemy, dropped a couple of small bombs—wide of their mark, thank God—and flew away. We stayed in a huddle for the rest of the day without food or water, but after dark five of us shared a small tin of sausages and a bottle of gin, then tried to sleep. The last ten days had been a tremendous effort but it had failed. That had been the luck of the game, however, and our tails were far from down. But we were too exhausted or still too wound up to sleep, and it was cold without blankets.

We sat there most of the next day, too, getting only a cupful of water from our captors. In the late afternoon, however, they loaded us, forty to each of several small lorries, and drove us north about thirty miles, there to put us into sheds in a dirty farmyard on the edge of an aerodrome. Still no food and we were still too tired to sleep. Next morning it was rumoured that we might be moved by air, and all day we sat on the edge of that aerodrome watching its considerable traffic. Then towards dusk we were told to march to a town a few miles away, where we went into empty barracks. That evening we each got a cupful of hot soup—the first food from our captors in three days—also something of a wash. More prisoners were brought in during the next few days and the barracks were soon overcrowded. Sanitary arrangements were almost non-existent, water was scarce and there were no medical facilities whatsoever. Flies became bad and soon some hundreds of men were going down with dysentery and like complaints. In these first days—and weeks—of capture everything seemed a grey blank without thought or feeling. We moved or lay down or ate mechanically, and it did not seem to matter much whether we did a thing or not. We reacted to nothing higher than our immediate circumstances—how to get clean or well, how to get a little more food. We lived as a herd, without privacy or real rest, on the scanty ration of a cupful of thin soup and a handful of broken biscuits twice a day, with flies, filth and dust our constant companions. We were prisoners, we slowly realized, but exactly what that meant we did not or could not grasp. Capture had come as such an anti-climax to our efforts, and it was difficult to fit our old world of realities into this new one. We lacked almost everything that made a difference to life and were hardly in good enough shape to fend for ourselves. But the possibilities of escape had not been entirely forgotten, and we managed to get two of our number over the wall one night and clear away: it took them six weeks of arduous travel before they were able to rejoin the British forces.

In the days that followed we tried to get ourselves and the place more organized. We needed many things, of course, and some of us had a little money. Our guards, learning this, were not slow to start a black market, charging ten shillings for a small packet of local cigarettes or a small tin of jam, eight for a cake of coarse soap and two for an egg. The Commandant was not helpful and we were soon in difficulties with him. He made no effort to stop the black market: he would not build latrines or give us the tools to do the job ourselves: he concerned himself with nothing but our soup and biscuits twice a day.

About ten days later they began to move us in batches. We were stowed tightly in lorries an hour or more before the start: the convoy moved slowly until evening with few halts except for a breakdown: we were then herded into some shed for the night, or, once, left in an open muddy field ringed in by machine guns. And not always was there food. Some of us were getting so weak that it was only with difficulty that we could get in and out of the lorries. Finally we halted on the outskirts of a large town and were put into half-built barracks. Our sick were at first refused admission to hospital, but one officer, so weak with dysentery and an inflamed leg wound that he could scarcely move, was eventually taken away that evening in a lorry. He was left in the dark at the hospital entrance and it took him fifteen minutes to crawl up a flight of stairs and find someone. An orderly pointed to a dimly-lit ward where the officer found for himself an empty bed and lay down. Not till midday next day, fourteen hours after his arrival, was the slightest notice taken of him, and in the following nine days all the attention he received was to be given one opium pill and be told to fill in innumerable particulars on a form. He was never examined and his septic leg was never dressed. Flies crawled on his already dirty sheets. The distant and unlighted latrine was blocked and its floor was inches deep in urine and filth. For food he could share what the convalescents ate or go without. After nine days he asked to go back to his friends in the half-built barracks outside the town. But there was one incident of a more amusing sort. The hospital had a matron and, though she could speak some English, she evidently had no love for England. Seeing from his form of particulars that the officer had been born in India, she hissed: "You Indian. You go Indian camp." "Oh! no, matron." he replied. "I was born in India. I am brown here and here with the sun, but I am white elsewhere. Would you like to see?" He had no more trouble with the matron.

We were soon on the move again, this time for a 600-miles journey. Two hundred and twenty-six of us, plus guards, were packed into six lorries; and for four long days we travelled thus, arriving at our destination with the same numbers packed into four lorries. Each day there was the same early loading up, the same hour or more of delay in moving off, the same long, tiring hours of standing, tightly packed, in a jolting, swaying lorry through driving dust or biting wind. Each night there was the same late arrival, utterly exhausted, too little or no food and to snatch a few hour's sleep on the floor of some dirty, draughty shed. Each day our sick grew no fewer. It was not a journey to repeat.

On the first day loading began at 6 a.m. and each of us was given a small roll of bread and a small tin of meat. But the lorries did not move off till 10 a.m. and then took another fourteen hours for the 160-miles run. At midnight we halted and were put into a dirty aircraft hangar without food, water or sanitation. A threat to protest to the International Red Cross was greeted with loud laughter by our escort officer. Next morning no rations and we were lined up at 6 a.m. But no lorries appeared till 8 a.m. and the 225 miles run took till 9 p.m. The country was barren and dusty; there were few settlements or even native encampments; and a cold wind blew. That evening our escort officer met a boy friend and got drunk. We had settled down to sleep in a reed hut when he came in, noisily and heartily. Where was the senior British officer? Would we like some food? We were his best friends, he said, as he swayed and clasped an officer round the neck. The officer shied violently in case he might be kissed, but we each got another small roll and tin of meat.

On the third morning we embussed at 5 a.m., with the usual two-hour delay in getting away and thirteen hours more on the 200 miles run. On this day there were far more than the usual number of breakdowns and we finally abandoned two of our six lorries. Everyone was packed into the remaining four, so that each of these now carried sixty men, including guards: sardines, one imagined, were comfortable by comparison. But we got into better country with less dust: there were farms, orange-groves and settlements, and much more development than we had seen elsewhere. That night our home was a large open shed which allowed the heavy rain to come in and the guard to pilfer our few possessions as we slept. The farther we went from the battle-area the worse was the behaviour of the local guards. The fourth morning took us, after a short run, to a large seaport town and we were put into barracks on the beach. Officers were shut into a large room whilst men were searched in the courtyard outside, and their watches, rings, pens, and money all taken away. Our protests were in vain, either at this or at the utterly filthy sanitary conditions of the place. Rather surprisingly, officers had not yet been thoroughly searched, beyond having to give up their revolvers.

We were now back to where railways existed and that afternoon we marched to the station. It was barely a mile but in our exhausted condition and carrying our few possessions that mile felt like ten. In the train, however, one could at least sit down, and few of us had done much of that in the previous four days. We travelled about thirty miles to another small town and were there put into some empty bungalows inside a heavily wired compound. It was less crowded and more comfortable than anything we had had since capture: we had water, camp beds and hot meals. The Commandant, too, was good and recovered almost all the things previously taken from the men. He also got us essentials like messtins and boots—some of us had travelled thus far with only the rags of socks on our feet. Most of all, he left us alone, and the three days there were a real rest which did us all a great deal of good. Again we began to think of escape, either westwards or else on the sea voyage which probably lay before us. But most of us were still too weak for a long trek, and in the time available we could not get hold of such essentials as maps and reserve food without which it would have been folly to attempt a break. Then, on the fourth night, we returned to the seaport town we had recently quitted and embarked on a big modern liner.

That ship was comfortable. We had cabins, clean sheets and towels, no dust or flies, hot water in real long baths, and plugs that really pulled. For us these were all rediscovered luxuries. We wallowed in hot water, fomented and dressed our various septic sores and minor wounds, felt clean again for the first time in weeks. The food, too, was good and it was a pleasure to see clean table linen again. We could get cheap cigarettes and playing cards. We invaded the ship's barber and quickly cleared his stock: he rushed ashore for more and again we cleared him out. For over a month few of us had had much in the way of soap or shaving gear: there were already beards among us and twelve officers had been sharing one toothbrush. The ship sailed that evening in convoy with a large escort, so that killed all our tentative plans for seizing her and steering for some friendly port: our only hope now lay in meeting the British Navy. But the convoy hugged the coast, dashed across the open sea under a strong air-umbrella and brought us to port without incident. Silent, pale and apathetic crowds watched us land and entrain, and we were soon on our way. Next morning we detrained and were taken in buses to a permanent prison camp. It was the end of the first phase of captivity. The last five weeks had been difficult and a heavy strain thrown immediately on top of a long withdrawal. They had been a period of little rest and few amenities, of poor and scanty food, of sickness that was hard to throw off. We were still weak and exhausted and some of us were definitely ill. We were tired, too, of dusty travel in crowded lorries, and the memory of these would not quickly fade. Since capture we had travelled nearly a thousand miles in lorries—as if from London to Rome—and every mile had been uncomfortable. But now ahead of us stretched an indefinite vista of we knew not what.

In The Bag

Prisoner of war camps during the last World War varied considerably as regards accommodation, the attitude of the camp authorities towards prisoners and the way prisoners themselves organized their lives. There was such variety, in fact, that one cannot easily generalize; but in the several camps of one of the Axis countries which we experienced the life was not one of horror and unmitigated misery. It was monotonous and uncomfortable, a time of pointless waiting; but it had its better, even its amusing, moments—largely because we made it so.

A great deal, of course, depended on the Commandant and his staff. Few Commandants were real brutes and most of them did their best—by their lights and within the narrow limits of Axis ideas on the subject. Some were practically invisible to prisoners, and relations were conducted entirely through interpreters who had no powers of decision or discretion. Others were more approachable and some even came amongst us on occasion. There was, of course, a vast fundamental difference in outlook between them and us, and this had to be realized if we were ever to understand them and their ways at all. Axis ideology was a thing of repression and bombast, a cruel tyranny and an unholy racket. Nobody trusted his superior, his subordinate or his neighbour. Power lay with the few and was generally abused. The top dog was always right and the others lacked initiative or just did not care. A few of the worst Commandants regarded all prisoners as the lowest of inferiors, but the better ones—and these were the majority—came, in time at least, to regard us as human beings, even as possible equals outside the circumstances of our status as prisoners. Many of them had once had a certain regard for the British and this was not entirely dead in their hearts. We learnt how to deal with both types, treating the one as we did ourselves and meeting the tirades of the other with silence and perhaps the faintest suspicion of a pained smile. This last was something quite outside our captors' experience and they did not know how to deal with it. It was, in fact, a most potent weapon against a race which for all its bluster of superiority had little ingrained self-confidence.

It was much the same with camp staffs—the junior officers, N.C.Os. and soldiers set to guard us. They were rarely their country's best, of course, and not many of them were soldiers except for the uniform they wore. By our standards they were often quite irrational, petty and maddeningly irritating. They would get very excited at what we considered to be trifles, yet care little for what seemed to be the bigger things. Right and wrong often depended very much on how a thing affected the individual, and so long as they personally did not get into trouble they would be inclined to shut their eyes to many things. They lacked deep pride in themselves and bothered much about "face" and a brittle "honour" instead. One might despise them. One might even feel sorry for some of them. But very few were really worth hating. Nor did many of them really dislike us. In fighting us, they realized after the first flush of success, their country had made a fatal mistake. In many cases their hearts were not in the war: they felt that in the end they would lose and they merely wanted to get it over as quickly as possible. Even if the Axis should win they could not look forward to much greater personal liberty, however much their masters might then strut the world: they almost preferred defeat and a fresh start without an ideology. In the days of their greatest successes, too, when Axis armies were sweeping forward on every front, they never boasted to us of victory: it meant so little to their private lives and, in fact, they did not always believe the victories reported in their press and radio. They were tired—so very tired—of war, and they could never understand our desire to escape and get back to it. "For you the war is over," they would say. "Aren't you glad?"

On the other side was our own attitude to the whole business. Capture had probably been the last thing most of us had expected, and mentally we had been unprepared for it. Coupled with the great physical strain of a long withdrawal, it had come as a profound shock: it numbed our senses, and the first weeks of capture were a grey blank of feeling as if we had been detached from realities. But the more settled conditions of a permanent camp in a more temperate climate worked a considerable improvement. The greyness lifted from our spirits and the sickness gradually left most of our bodies. We were prisoners, we now realized clearly, and more so than ever in these heavily-guarded camps. The war would go on without us and we were powerless to help in any way: that was one of the worst angles of captivity—the inability to do anything more. But the war would not last for ever—though how long, we could not even guess—and, if we were marking time for the moment, we might catch up on life later on. We all wanted liberty, but liberty was what we could learn to do with it when it came. Everything therefore depended on keeping ourselves physically and mentally fit, on retaining our pride and self-respect, and on finding in our difficult circumstances some purpose in living. For the time being our first duty was to ourselves, so that we could readjust our outlook and get accustomed to the idea of captivity without feeling the rub of the chain at every turn. We had to learn to think and act as rationally as possible, to "get on working terms with the inevitable", and to forget our surroundings. This was not defeatism; we hated captivity—intensely at times—but we were forced to accept it. But unless we could shut our minds to our immediate situation we should never be able to see past captivity and never be ready for liberty when it came. Some lines in a letter seemed to express what most of us were trying to cling to:

A heart to face the world and find God in it.
Eyes blind enow but not too blind to see
The lovely things beyond the dross and darkness
And lovelier things to be.

Henley's "Invictus" also came as a strength to many of us:

In the foul clutch of circumstance
I have not winced or cried aloud.
Under the bludgeonings of chance
My head is bloody but unbowed.

It matters not how strait the gate,
How charged with punishment the scroll.
I thank whatever god there be
For my unconquerable soul.

We tried to take it like that and this possibly accounted for much of our captors' bewilderment and exasperation. We were their prisoners, but we retained some secret strength which they were quite unable to understand or to break.

There were difficulties, of course; and our youngsters perhaps had the hardest time of all, as captivity with its endless waiting and utter pointlessness was a terrible strain without some sort of philosophy. Many of these youngsters had felt they had had the ball at their feet and they had done magnificent things in the game of war that was so new to them. Then their world had collapsed and they had little left to cling to. Some survived grandly and it was good to be in the company of such as these. A few cracked—or nearly so—and sought outlet for their ragged nerves in laxness of habits and manners, in escape plans that could not possibly succeed, and in uselessly baiting and irritating our captors. In this last they missed the essential point, however; for, whilst it was our purpose and duty to force our captors to expend as many of their men and resources as possible away from the battlefield, we achieved nothing towards this by merely annoying a few interpreters and sentries.

With this as background, one may turn to the ordinary daily life in some of these camps. After the primitive conditions of the battle-area we had come from they were, of course, an improvement. We got more regular and somewhat better meals. We could keep ourselves and our clothes reasonably clean. We slept in bunks or beds. Accommodation naturally varied a great deal between the various camps, from cold, damp huts to schools, monasteries or hostels; from long dormitories to small rooms or cubicles. One camp, by no means the best, had the somewhat incongruous postal address of "The Fountain of Love". Whatever the building, however, high walls or several belts of high barbed wire formed a normally unscalable perimeter. Sentries patrolled outside that perimeter at fifty paces interval and it could be floodlit at night. Other guards patrolled amongst the buildings inside, keeping watch on our activities. There were also high watch-towers which commanded the whole area within the camp. Huts and rooms were generally inspected twice a day for signs of tunnelling, loosened window-bars or other nefarious activities. We were mustered for counting and roll-call thrice a day, whilst during the night patrols would come round at intervals to ensure that every bed was occupied by a live body and not a dummy. Altogether our captors took good care of us—for they were proud of their bag—and there were not six consecutive hours in the twenty-four without some evidence of their interest in our continued presence. Escapes were not easy in such circumstances.

Our captors had, we thought, remarkably poor ideas on sanitation, water supply and heating. Drains might be unflushed for days but they did not seem to mind either smells or flies. Water was generally quite inadequate and was normally turned on for only two half-hour periods each day. Long baths were, of course, something quite forgotten, but there were showers from time to time and sometimes they were hot. Winter could be long and bitter, but it officially lasted for only three months and for only four hours out of every twenty-four during that time. At least, we only got wood for stoves—we never saw coal—during these three months and on a scale just sufficient to keep a small fire going for about four hours a day. In winter we were always cold, and even if we skipped or walked with greatcoats on we were generally exhausted before we were warm. The scale of stoves depended on the type of accommodation, but in one camp averaged one to about forty men. Yet it was remarkable what they could get out of that stove in four hours—mugs of warm water for shaving or Red Cross cocoa, warm stones or bricks as footstools or to heat our beds. Lighting was another difficulty, for not only was the scale inadequate for easy reading but it was sometimes not turned on until well after dark. But if the camp authorities forgot to turn if off again on cold winter mornings we would leave it burning, as this made a slight difference to the temperature of our chilly habitations.

On the subject of food—or its scarcity—one might enlarge almost indefinitely. We were not allowed the rations for depot troops, but were classed as "non-workers" on a much lower scale. It was monotonous food and mostly soft stuff that required no chewing. Such meat as the camp authorities provided was mostly of the "offal and lights" variety, and some of us will remember meals of animal windpipe exactly like the rubber hosepiece of a respirator, and as tough. Potatoes we never saw. The egg ration, officially one a week, was in fact one in six months. "Carrots" meant only the green, feathery tops and we could guess who got the rest of the carrot. The total ration grew less and less until it weighed only 10 oz. a day—half of which was bread—and contained, according to our doctors, not more than 1,300 calories. The only proper meat we had came from our all too infrequent Red Cross food parcels. These were supposed to be on the scale of one a week and it was not the fault of the International Red Cross that this was not so; but we spent one long, bitter winter with only three parcels in fifteen weeks. Most camps organized canteens, some good, some less so, but too often the camp authorities would try to foist on us the unfilling luxuries which neither they nor the civil population could afford to buy. Yet, because we were always hungry, we bought these things. We had all lost a good deal of weight, and the average man who had weighed between eleven and twelve stone before capture might be down to eight or less. This in itself was not serious, but it meant that few of us had much stamina for physical effort such as escape. Prisoners sometimes fainted from weakness whilst standing on muster parade. Finger-nails softened like rubber and peeled off through lack of calcium. Circulation troubles developed in the form of leg cramps whilst we slept. Later, when some of us escaped to the woods, we found trekking, carrying loads or making light shelters for ourselves an enormous strain on our limited strength.

Red Cross parcels, scarce though they were at times, proved a godsend to us all, and were the main source of such health and strength as we managed to preserve. The meat, butter, sugar and chocolate were particularly welcome. Chocolate was, in fact, so precious that we rarely ate it casually but hoarded it against possible escape. In addition to these food parcels we were allowed one private clothing parcel every three months, besides parcels of books and tobacco. Some of us got most of our parcels but many of us considered ourselves fortunate if we received one third of the books and tobacco sent to us. Where the leakage occurred we could never discover, but we did not entirely blame the camp authorities. These parcels came through many hands on their way to us and not every handling agent was imbued with a burning desire to speed them on their way to the prisoner. But parcels were an excellent form of propaganda of which we made the most. They had to be opened before the camp authorities; and the interpreters and guards would goggle at the food, warm clothing, tobacco and books they unpacked, as these were of a quality and quantity they were quite unable to obtain for themselves. Were their newspapers after all quite right in all they said about starving England?

It was much the same with letters. On inward letters there was officially no limit, but there was the very real bottleneck of the local censorship department, where letters might be long delayed or even thrown aside in sackfuls by censors too bored to go on with their job. It was not uncommon after the war for senders or returned prisoners to get bundles of letters marked "Recovered by Allied Troops." Letters tended to come in spasms: one might get a dozen or more in one day, then nothing at all for the next two months. Some letters came reasonably quickly, but there were instances where they took a year or more to reach us. Our own outward mail was rationed to a small lettercard and smaller postcard per week, and neither had the space for more than what was little else than a telegram. We all developed a telegraphic sense, omitting non-essential words so long as we could satisfy the local censor that it was not a code. Some of us, of course, had private codes with friends at home and it was astonishing how much news got through if it was well wrapped up in racing, cricket or gardening slang which was quite beyond the wit of most Axis censors. On our side some pleasing reference to our food or comfort sounded good to these censors, but the fact that it was coupled with an injunction to inform the Marines would entirely escape them.

The pay system to prisoners varied amongst the Holding Powers. In our case, officers were paid the basic pay of their equivalent rank in the army of the Holding Power, receiving this in special coupons which were valueless outside the camp. But from that pay the camp authorities promptly deducted a fixed and considerable sum for our messing, and this bore particularly grievously on junior officers. In time the British Government granted us ration allowance, but it was never equal to the messing rate we had to pay. Soldiers were messed free and got the equivalent of about threepence a day as pocket money. We would have objected to none of all this had it not been for the completely artificial rate of exchange agreed between the two Governments for these payments. This bore little—and decreasing—relation to the value of money in the two countries, and, later, when we were free, we found that it was about six times less favourable than the existing official rate. A lieutenant-colonel, for example, was debited with twenty pounds a month at home for what he received in camp, but when some of us later escaped to a neutral country we found that that month's pay would buy only one bottle of gin—for twenty pounds!

Our average day would, of course, depend on the camp, the season and the individual, but it might be something like this. Morning muster at 8 a.m. and we fell in: the names of any sick were reported by the doctor: the interpreter called the roll, each of us answering our name and passing across the courtyard to fall in again on the other side and be counted. Breakfast might be a bowl of substitute coffee and one half of our 5-oz. daily roll, with any margarine or jam left over from our last Red Cross parcel. The morning might be taken up with classes or else one read or did minor laundry or mending. The camp barbers would function—two young R.A.F. lads who accepted a cigarette in exchange for quite a respectable haircut. There might be some private parcels and that meant a rush to queue at the store. Midday muster and then lunch, which might be a mess of boiled onions: how sick one got of onions, but there was nothing else. The afternoon would see more classes or one would read or sleep, or else queue if the canteen had something to sell. "Tea" was a brew we each made for ourselves in the kitchen, using our tea-leaves twice or more if parcels had been scarce: with it would go some Red Cross biscuits or the rest of our roll. Passball after that and then evening muster. Dinner would be more soup, of carrot tops perhaps as a change from onions, and with a faint trace of "meat". There might be boiled figs if we had been able to buy any. In the evenings bridge, poker, reading, a gramophone concert or a lecture from one of us might fill the time. Once a week we had a reading of news culled from home letters or from such of the Axis press as we were allowed to have. "Lights Out" at 11 p.m. and then patrols round the courtyards and rooms during the night. So much for the bare framework of the day, but into that would be fitted many other activities. Tunnel work went on somewhere almost all the time. Escapers would be making kit, maps or forged passes. Guards would come round to tap walls or floors or shake window-bars. Or the camp authorities might decide to have a general search.

Most camps soon became veritable hives of scholastic activity, with classes in a wide range of subjects—several languages, tactics, the conduct of the war such as we knew it, political history, economics, finance, law, mathematics, engineering and the like. We got little help from our captors but they would generally allow us to buy dictionaries and we could get other useful books in our private parcels. It was astonishing, however, to find so much instructional talent with so little help in the way of manuals: one officer might lecture on political economy, another on mathematics, a third instruct in some language—all largely from memory. In one camp a six-months course in elementary tactics was held for some sixty officers, with lectures, discussions, simple demonstrations in a big shed, and exercises carried out on large, prison-made, wall maps of imaginary country. There were difficulties, of course, as we had to keep this particular work secret from the camp authorities. But if an interpreter came in during one of our tactical lectures there was no excitement and the lecturer at once swung off into a talk on some completely different subject which he had ready in his mind. Our wall maps caused questions until we explained: "Well, you know the Australians in the camp have been giving us a dose of lectures about their own wonderful country. This is Britain's revenge—lectures to the Australians on English huntin', shootin' and fishin'." It satisfied an interpreter who knew nothing of these things, and the maps and the course survived. All this activity on our part served a double purpose. It was part of our effort to keep mentally fit and to do something useful with our ample leisure. It also took our minds off ourselves and our circumstances. With most of us it achieved both these ends, for there were few who took no part in these studies or failed to get some value from them.

As to our lighter amusements, few games reached us from the Red Cross in the early days. But we organized passball, boxing, highland dancing and even unarmed defence. We danced reels and highland flings at Christmas and on Burns' Nicht, much to the astonishment of our guards who regarded them as quite definitely some form of savagery. Some of us knitted furiously. There were occasional theatricals, a Christmas pantomime or a mock court-martial. Most camps in time formed fair libraries from the many private books sent to us. We were allowed a tot of troops' wine or a glass of vermouth—at a fantastic price, but at least they reminded us of what drink used to be like. Any excuse was good enough for a party—an escape whether successful or not, our captors' discovery of a tunnel, somebody's return from a spell of solitary confinement in the "cooler". The host or hosts would invite his guests, buy up their wine rations, doctor them with sugar or fruit juice to make them more drinkable, and the party would be a success—to the unending surprise of the camp staff who consistently failed to understand why the mad English should thus keep so cheerful or should want to celebrate what could only be properly regarded as a catastrophe. By saving hard on our Red Cross food, which we pooled, we actually managed a three-course dinner one Christmas. And with it went a fair imitation of a cabaret show from our camp orchestra. It was really a magnificent Christmas, even though our shrunken stomachs afterwards rebelled at so much food and gave many of us violent pains. But its very cheerfulness hurt by accentuating our sense of captivity, and some of those lovely haunting tunes tugged sharply at the strings of memory: the chain chafed most of all on these occasions.

Prison life had its good and bad points. It could be depressing and selfish-making, yet one saw sincere cheerfulness and many great little generosities. It was largely a useless life, of course, unless one took active steps to prevent this, but one learnt self-restraint and possibly patience. It held little challenge or incentive, yet most of us managed not to go animal and we formed surprisingly sociable communities on the whole. Perhaps we became less tolerant of some things such as selfishness, more tolerant of others such as human frailty. The small things of life seemed even smaller, but the prime simplicities took on more of their true grandeur. One learnt to see and think past circumstances and superficialities and to hold on to freedom of spirit. This was, in fact, our most precious, our only real, possession, and nothing our captors might do could take it away from us. As far as we could, we made the best of our time. After the initial phase we rarely thought of captivity as such: we might think of the past, more of the future and what to do with it, but little of the present. We had got on working terms with the inevitable. But let it never be forgotten that most prison camps were fundamentally bad, in their material discomforts and poor food, in the almost stagnant existence we led and in the utter pointlessness of our lives during these long years. They were saved from being quite damnable by ourselves and only ourselves, by the spirit of give and take which we unconsciously developed and by our determination not to be beaten either by circumstances or anything our captors might do. Camp populations were mixed bags, with good chaps and a few bad, but mostly the ordinary everyday sort as any army is in wartime. Yet without written rules, without much obvious "discipline" we mostly played the game. And in the aggregate we had a moral strength which was far beyond anything our captors could emulate or break. We had sunk into greyness and depression at first, as much because of physical exhaustion as anything else. But we had climbed out of that and thereafter, till the end, our tails were never down. To the world we were a lost legion, but to ourselves we were something better. We kept our minds as active as possible and our bodies as fit as conditions allowed: we could look beyond the dross and darkness. And because of that our captors came not only to respect us but to realize increasingly that they had been wrong to make us their enemies.

(To be continued.)

SUBMARINE MINING

The Life and Death of one of the Corps Offspring, 1871-1905

By The late Brig.-General Sir James E. Edmonds, C.B., C.M.G., D.Litt. (Oxon), R.E. (Ret.)

Note—This article was written by Brig.-General Sir James Edmonds a few months before he died at the age of 94. A Memoir is published in this issue. As he states at the beginning of the article it adds some details of the submarine mining service which are not in the history. The article also illustrates his own wonderful memory and shows touches of his sense of humour which he maintained to the end.

FORTY-SIX years ago, in 1910, *A History of Submarine Mining* by Colonel Baker-Brown, R.E., was published. To some of the present generation its title may offer no clue to what it is about; it is not an account of coal-mining below the sea, but the story of how the laying of sea mines as obstacles in the defence of coast fortresses, coaling stations and commercial ports was assigned to the R.E., and how the service grew and was carried out until its abolition. No less than 252 Regular officers, R.E., were employed in it, and at the end its total personnel, Regular, Militia and Volunteers, numbered 5,890.

The book, of 280 pages, is more of a pious memorial volume than a true history, being largely filled with the posting and movements of officers, even their deaths, and containing not only lists of the Regular officers, but also those of the very many Militia and Volunteer officers who became Submarine Miners, with skeleton histories of the Regular companies, including lists of their commanders; and providing tables of how the various appointments of S. of S. for War, C.-in-C., Inspector General of Fortifications, Commandant S.M.E., Inspectors of Submarine Defences (Home and India), Instructors and Assistant-Instructors in charge of schools, were filled—names all now forgotten. The year-by-year narrative seems to have been extracted from the annual reports of the Inspectors of Submarine Mining, with little atmosphere and without mention of some of the essential features of the service. There is no clue to the fact that submarine mining, originally officered by eminent cricketers, Pollock Medallists and coming electricians, with facilities for yachting, sea fishing and learning the development of the applications of electricity—it is stated that the original rank and file were "the pick of the Corps"—degenerated into almost a "Correctional Battalion", into "C.B.", as its Coast Battalion was known.

As for its abolition, the late Major-General Sir Robert Ruck, one-time Inspector of Submarine Mining, states in his Introduction: "I found the task [of writing] somewhat difficult owing to the circumstances under which this very efficient service was terminated. I feel the time has scarcely yet arrived when the subject can be fully discussed." This gap I can at any rate fill.

The American Civil War of 1861–5, in which torpedoes and mines (using gunpowder) were developed and effectively employed—thirty-seven vessels being disabled or destroyed—brought home to the British Government that "something ought to be done about it", and on 8th September, 1863, a joint naval and military committee was appointed to take the matter in hand. This committee of elderly officers did not report for close on five years, in July, 1868. It recommended mines as "most valuable auxiliaries to permanent coast and river defences", it "definitely recommended" the use of guncotton in preference to gunpowder; and it "strongly recommended" the use of electricity as the firing agent; as to moorings it suggested further experiments.

Two years later, in July, 1870, a technical committee of five members, an F.R.S., a naval officer and three R.E. officers (Lieut.-Colonel, Captain and Lieutenant) was appointed to report on "the form, composition and machinery of mines". Thanks to the experiments which meantime had been carried out by the R.E. Committee and the Instructor in Telegraphy at Chatham, the technical committee presented its report in two months and a week. It regarded as firmly established the pattern of mine case, the explosive agent, the nature of electric cable, the form of firing battery and the mooring arrangement (a sinker); but as still open to discussion the choice between two kinds of fuse and two kinds of circuit closer.

This report was referred by the War Office to an "influential committee" of elderly officers, which reported two months later. It adopted the report of the technical committee, and then discussed generally submarine defence for military stations at home and abroad, of the great commercial ports of Great Britain and of other places of importance, and the staff, the vessels, the stores and the electric lights required. The purchase of material for six stations was authorized, and the 4th Company, R.E., just home from Bermuda, was selected in April, 1871, for conversion into a submarine mining company, with a strength of ninety-three other ranks. At the same time it was agreed that the Navy should carry out the water work and the R.E. the electrical work.

There were to be two kinds of mines, "electro-contact" and "observation" (fired eventually by a Watkin Position Finder), both controlled from a "Test Room" on shore.

The contact-maker when the mine was struck was a small steel ball seated on a spiral spring. The position-finder consisted of a pivoted arm, on which a telescope and a vertical pointer were fixed, placed over a chart on which the observation mines were marked by tiny metal discs: the approach of a vessel was followed with the telescope and when the pointer came in contact with a disc up went the mine.

Other nations, it may be said, merely developed the "mechanical mine", which contained its own means of firing, and was dangerous to friend and foe alike.

In preparing a minefield the first thing to be done was to take accurate soundings, by means of marks on shore and sextant bearings. Then the cables could be cut and the moorings of the mines prepared for the different depths. This done they were put into store, the cables in tanks of water. The mines were kept loaded with damp guncotton, with the priming charge separate in a cylinder, to be inserted when the mine was required.

The unit of a minefield comprised a "main cable" from the shore to a "junction-box", from which branch cables led to the several mines.

A depot and a school of instruction were established at Gillingham, on board H.M.S. *Hood*, an old wooden three-decker, and the submarine-miners, clad in pea-jackets, blue jerseys, and stripeless trousers, settled down to a Medway life, speaking of the brethren in Brompton as "barrack beasts". In 1884, however, the depot was moved to St. Mary's Barracks, and the *Hood* abandoned.

After the stores at a station had been prepared there was little to do except to keep them in order. It was soon established that there should be a "Practice" every year, its object being to rehearse as far as possible the laying of at least a part of the minefield—the mines being loaded with sand or gravel instead of guncotton—and then to clean the stores and put them away again. A practice usually lasted three months; and the record for laying mines was ninety per mooring vessel in a working day of ten hours. In the five months in which I was in Malta, November, 1884, to April, 1885, no submarine mining whatever was done and little else except a weekly drill on a very small parade ground, under the adjutant, and the men got somewhat out of hand.

The first places tackled were the dockyards, Chatham, Portsmouth, Plymouth, Pembroke, and Cork; then the commercial ports, Humber, Tyne, Forth, Tay, Clyde, Mersey, Falmouth, Belfast, Dublin; and finally overseas, Malta, Bermuda, Halifax, Ceylon, Singapore, Hong-Kong, Mauritius and India, and fortress company after company was converted to submarine mining, until the total was thirteen.

As early as 1875 the Navy found difficulty in allocating the men for the water work, and two years later it was decided to raise local militia and volunteers for this part of the service. The scheme was an immense success, as it was backed by eminent yachtsmen at the various ports. Local militia were also formed at Malta and

Bermuda. As Malays were good boatmen it was decided in London to raise a battalion of four companies for the defence of Trincomalee, Singapore, Hong-Kong, and Mauritius, and the R.E. staffs for them were dispatched. Then it was pointed out that Malays did not want to serve abroad, and that the local boatmen at the other stations were excellent. So it was decided to form an "Eastern Battalion" of four local companies and R.E. staff for them was dispatched. I recall that at Hong-Kong in 1887–8, to which place I had been sent with the 33rd Company from Malta in the Russian scare in 1885—the other two officers were on the sick-list and did not rejoin—and I found on arrival the 31st Company, also with only one officer who was at once sent home sick, and a small detachment of the 23rd Submarine Mining Company, without an officer, neglecting the stores. My Company Sergeant-Major, A. Bruton, used to call the parade, of little over a hundred men, to attention with "23rd Company, 31st Company, 33rd Company, Malays and Easterns".

All had been well with the Submarine Mining Service into the middle eighties; but with the Egyptian and Nile campaigns on hand, it began to dawn upon the officers that their brand was "non-medalliferous", and recruits had to be "pressed" into the service. To remove this slur it was decreed that should a war occur and live mines were laid, the submariners would qualify for the ribbon. And further (all this is not in the History)—Captain Dumbleton, a most eminent cricketer and miner, was dispatched—I cannot remember the year—with a party of Submarine Miners, with instructions to blow up the Second Cataract of the Nile. On arrival he was issued with two barrels of trade gunpowder. There was nothing doing; but he soon learnt that coffins were much in demand; so he and his men set to make them; and in due course received the medal and star.

Another blow was the organization in 1883 of a "Coast Battalion" to take charge of the stores at Militia and Volunteer stations; as already noted, it was referred to as the "C.B.", and the letters were translated as "Correctional Battalion".

It was not until 1891 that it was formally decided the Submarine miners should take charge of the electric lights at all ports defended by mines; at other ports, like Dover and Gibraltar, special sections were added to the Fortress Companies and in 1897 the Volunteer Corps of Electrical Engineers was formed, with Lord Kelvin as colonel, to provide assistance.

In 1887 the Brennan Torpedo was adopted, placed in Submarine Miners' charge, and established at seven Home ports.

This torpedo was a most ingenious invention by a Mr. Brennan. The War Office bought the patent and Brennan came to Chatham to develop the invention with the Corps. It consisted of a torpedo fired from the shore which could be accurately controlled as to direction and depth.

Two reels of thin wire were wound on two drums inside the torpedo and passed through a hollow propeller shaft to two winches on shore controlled by a steam engine. The wires were hauled in by the two winches and so rotated the drums which worked two propellers. By a special cam arrangement, when one wire was worked faster than the other, a rudder on the torpedo was moved and so it could be directed as required. There was a gyroscope which controlled the depth at which the torpedo travelled. Its range was 2,000 yds.

The placing and maintenance of booms had been left in naval charge. Thus three services, the R.N., the R.A., and the R.E., were concerned in the defence of a port, and proposals were several times made that S.M.S. should be taken over by the R.N. (one in 1877 by the late Admiral Lord Fisher, then Captain of the naval gunnery school, H.M.S. *Vernon*); by the Royal Marines; or by a special Coast Defence Corps. But all were rejected.

Then in 1903 the submarine boat, actually devised during the American Civil War, but abandoned after the experimental vessel had drowned four crews, finally embedding its head in its target-victim, became a practical instrument. The Admiralty (Admiral Fisher being Second Sea Lord) stated that it was prepared to allot submarines to the principal ports and that the mine defences could be withdrawn. It was further stated that at ports where submarines formed part of the defence, minefields were inadmissible as they would interfere with free manœuvre. The argument was not advanced that the electrically controlled minefields were too close to shore to be of service under modern conditions, except to block straight run-through channels like the Solent, the Dardanelles, Long Island Sound, Singapore, the Lyemoon Pass at Hong-Kong and the Straits of Shimonoseki. Nor was it mentioned it had been suggested in the U.S.A. that minefields could be cleared from a distance by means of high explosive charges fired from the Zalinski pneumatic gun. In any case, on the advice of the recently created Committee of Imperial Defence, the Government yielded to naval pressure, and in 1905 the Submarine Mining Service, except the searchlights, was scrapped and its apparatus handed over to the Navy, and part at least disposed of at Dockyard sales: one of my ex-sergeants at Portsmouth bought the detonators, damped them and took out the platinum wire, which he sold for a tidy sum.

In 1914, Admiral Fisher being First Sea Lord, the Admiralty asked that the R.E. Submarine Mining service might be re-established; but there was not enough R.E. personnel to provide three field companies per regular division, which had then been authorized, so the Admiralty invitation had to be declined. One wonders how soon the R.A. will be called upon to reconstitute the coast batteries.

PRESERVATION OF PIPES BY CEMENT LINING

By MAJOR R. J. P. LANE, M.I.PLANT.E., R.E.

THE requirement arose in this Command (FARELF) for certain classes of piping to be preserved against the rapid deterioration of the bore, due to the peculiar water in this area.

The problem of the design, manufacture, installation, and operation of a preservation plant was given to the Engineer Base Workshops, FARELF. It was decided that the preservation method to be investigated first would be cement lining, if this was not successful, other methods would be considered, and as will be seen later, the cement lining was quite a success. The aim was to preserve 500 F.R. of 4 in. to 9 in. piping per day.

It was decided that the plant would consist of:—

(i) Internal or bore cleaning machine.
(ii) External cleaning machine.
(iii) Spinning rig.
(iv) Bitumen dipping tank.

As an afterthought, it was decided to substitute a bitumen spraying machine for the bitumen dipping tank, and to add a mechanical puddle mixer for mixing the cement and sand. The whole plant would be sited on a spur between the Workshops and E.S.B.D. as good access roads were available for the inward and outward movement of the pipes.

The spur, which was of grass, was cleared, and a concrete apron put down, the size of this being 140 ft. × 25 ft. and 6 in. thick, with a hardstanding of 6 in. granite, 65 ft. × 25 ft., at each end, for the stacking of the incoming and outgoing pipes.

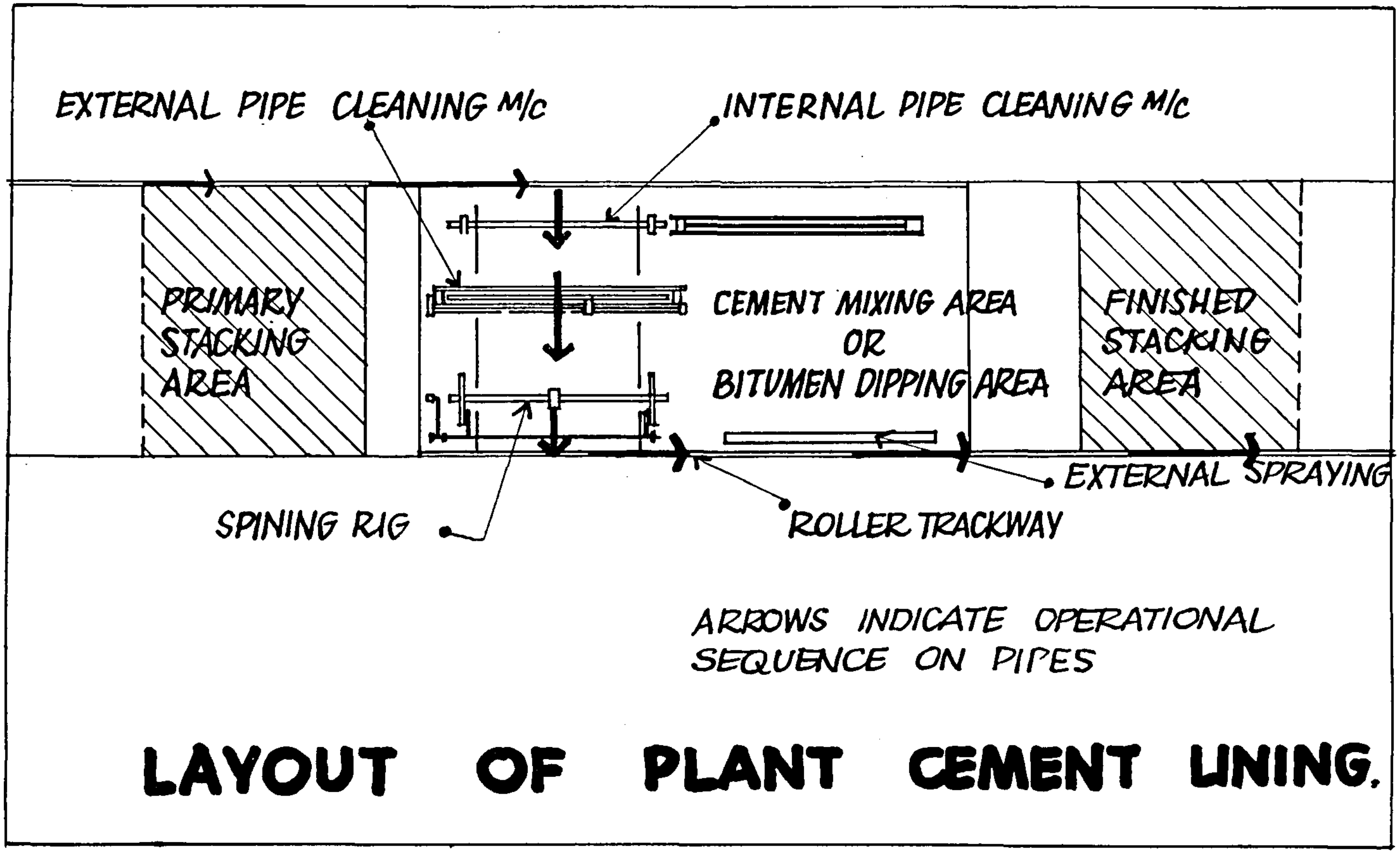
The actual plant was covered by three 25 ft. × 25 ft. portable huts of tubular steel frame and C.G.I. roof; no sides were fitted due to the climatic conditions.

The details of the plant are as follows:—

(i) *Internal or bore cleaning machines*

The first idea for this was to fix a circular cutting head, of four cutters, and immediately behind this head a wire brush, the whole mounted on a 2 in. spindle of tubing driven by a 7½ h.p. motor. The length of the spindle carrying the head was 30 ft., in order to clean the longest pipes in stock. The support of the spindle, as the head moved into the pipe, was the stumbling block to this method. It was then decided that the pipe would have to be the movable piece, the spindle remaining stationary in the horizontal plane, and the pipe being moved forward to the revolving cutting head and cleaning circular wire brush.

Decauville track and two trolleys were utilized and frames were designed for the trolleys to which the pipe was clamped. The system was moved forward and backward by hand. This operation took


EXTERNAL PIPE CLEANING M/c
INTERNAL PIPE CLEANING M/c
PRIMARY STACKING AREA
CEMENT MIXING AREA OR BITUMEN DIPPING AREA
FINISHED STACKING AREA
EXTERNAL SPRAYING
SPINING RIG
ROLLER TRACKWAY
ARROWS INDICATE OPERATIONAL SEQUENCE ON PIPES
LAYOUT OF PLANT CEMENT LINING.

three men to carry it out. The results obtained were quite effective, the rust, etc., which had been removed from the pipe was blown out by compressed air from a spraying machine compressor, after the cleaning head had been withdrawn.

(ii) *External pipe cleaning machine*

This machine was designed to clean the outside of the pipe of rust, scale, etc., and it was decided to use the lathe and travelling saddle principle, using two circular revolving wire brushes, mounted on the saddle.

The machine consisted of the following:—

(*a*) The bed, which was constructed of two R.S.Js. 8 in. × 4 in. × 36 ft. long supported by five channel iron legs which were fixed to the floor.

(*b*) The lead screw was made in five portions, each of which was turned separately, and joined by means of a shouldered male and female joint, and pinned. The screw was of 2 t.p.i.

(*c*) The headstock was completely designed and manufactured by E.B.W. with the exception of the four-jawed chuck; incidentally this item and the various electric motors were the only items that were not made in the Workshop. The headstock was driven by a 12 h.p. motor geared down to the ratio of 10: 1 by a worm and bevel drive. The drive to the lead screw was by means of five vee belts, the final drive for the rotation of the pipe being 140 r.p.m. The tailstock was of the usual clamping down type, except that it had a very large revolving centre, in place of the small fixed centre, the sides of the large revolving centre fitting tight on the inside of the pipe to support it.

(*d*) The saddle was fitted in the usual manner and the longitudinal traverse was operated either by hand or automatically by means of the lead screw. The cross traverse was by hand only, and adjusted the twin circular wire brushes which were mounted on a spindle connected to a 2 h.p. motor which was mounted on the saddle itself. As no self-winding drum for the electric cable feed to the motor was available, and the use of bus bars was not satisfactory, a catenary wire of No. 4 S.W.G. copper wire was erected on the trusses of the shelter, with twenty-five reel insulators fitted, the electric cable feed to the saddle motor was looped on the insulators, and from the last insulator the cable was in conduit with a straight down drop on the saddle. This method proved most satisfactory.

(iii) *The Spinning Rig*

This of course was the most important piece of equipment in the whole plant. A great deal of thought was put into the design and it was decided to employ the free spinning principle, which meant that the pipe under process would have to be supported at both ends and spun at the required speed cradled on two endless belts driven by pulleys.

The whole of this rig was installed in a pit about 1 ft. deep which had small drains to the main side drains, as it was known that there would be quite an amount of water and slurry when the plant was operating. The rig was fabricated from standard joist sections and channel iron, and of all-welded construction. At each end was a stand to which were fixed four pulleys, the drive being only at one end, to one pulley, by means of a sprocket and chain driven by a 10 h.p. motor. On test it was found that the best speed of spinning the pipe was 900 r.p.m. This brings to light a story with a moral. The first motor fitted was reputed to be of 800 r.p.m. according to the motor data plate which was fixed to it. After starting the rig, the pipe being spun nearly jumped out of the belt, as it was revolving far too quickly. Shutting down very quickly, the motor speed was tested by tachometer, and was found to be 1,800 r.p.m.! Therefore, never trust maker's details if it is possible to test them.

The rig was fitted with a centre guide plate which ran between two rubber wheels. This was to stop any lateral movement of the pipe, and "creeping" off the belts. The belt presented quite a problem on its own. After consideration the belt selected was a 6 in., 5 ply, ballata endless belt, 17 ft. 10½ in. long. It was estimated that the belts would last about three months.

(iv) *Puddle Mixer*

A puddle mixer was considered essential for this type of work to obtain true mixing of the sand and cement. This was manufactured and conformed, more or less, to the usual design of this type of plant.

The charging of the pipe with the cement mix was by a trough which was filled with the mix. This was pushed manually into the pipe, turned upside down and briskly shaken, then withdrawn before the pipe was spun.

(v) *External Preservation*

As mentioned previously this was originally to be done by dipping the pipe, after cement lining and blocking off of the ends, into a tank of bitumen, but after further consideration it was thought that the spraying of cold bitumen would be a far cleaner, cheaper and better job. Therefore a small pipe revolving rig was made, driven by a 1 h.p. motor, the pipe being laid on the top of the rollers and revolved very slowly whilst the pipe was sprayed by hand.

The next item, after the plant had been constructed and was in running order, was the actual cement lining of the pipes, and for the purpose of tests 6-in. pipes were used. Various mixes were tried and great difficulty was experienced in getting the lining to dry out sufficiently in the required time. The aim was to spin the pipe for ten to fifteen minutes. The cement lining then had to be set enough to allow careful handling through the external bitumen spraying process and then to the stacking area.

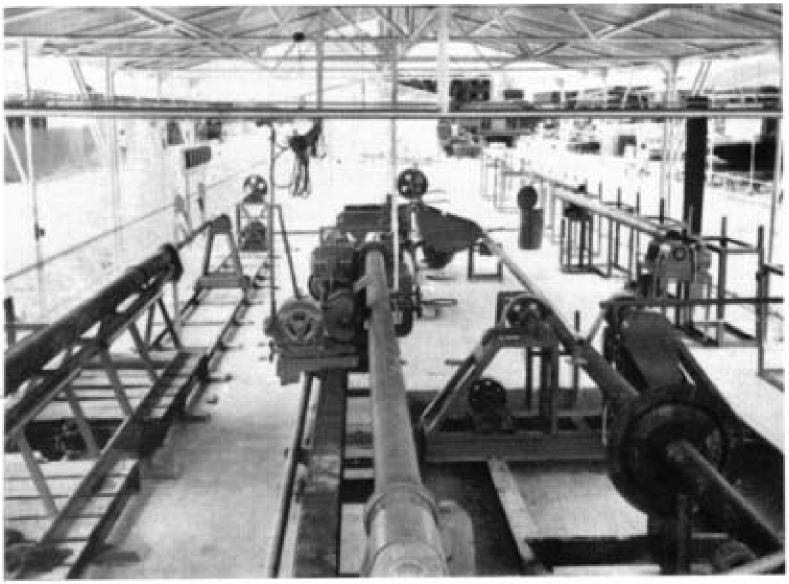


Photo 1.—General arrangement of plant (inward end).

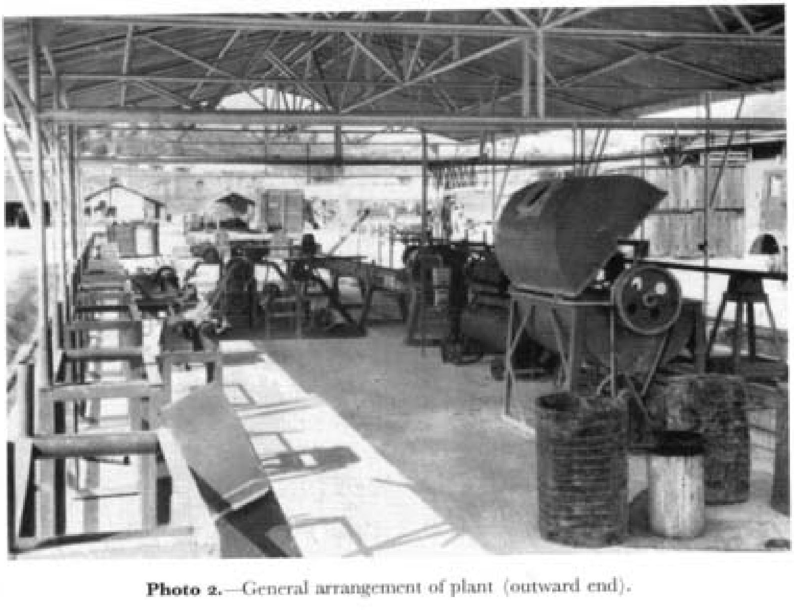


Photo 2.—General arrangement of plant (outward end).

Preservation of pipes 1,2

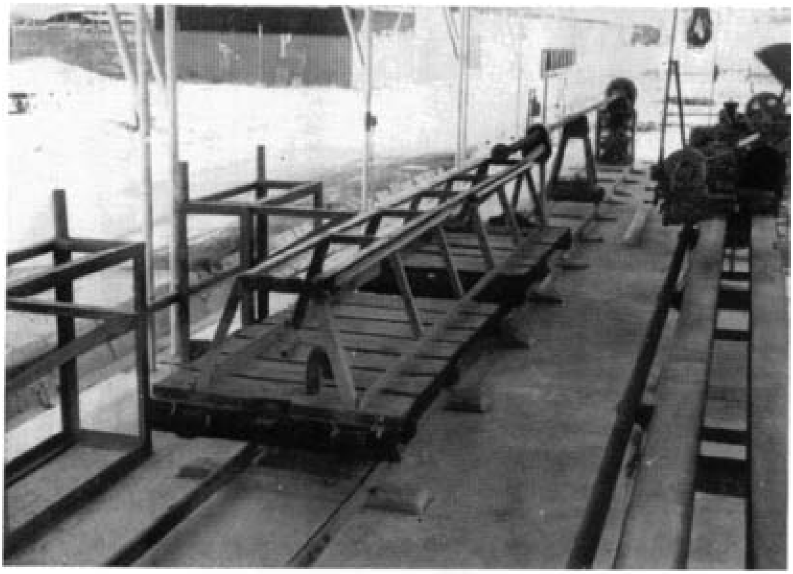


Photo 3.—Internal cleaning rig.

Photo 4.—External cleaning lathe.

Preservation of pipes 3 & 4

This could not at first be attained, as it was found that in spite of trying different mixes the lining was too soft. Anhydrous Calcium Chloride was used as a heating agent, but this did not decrease the setting time, and a foam deposit was left in the pipe. A quick setting cement was also tried, but this proved unsuccessful, and also had the disadvantage that it was impossible to make a batch for several pipes, as was possible with Portland cement. Eventually, after many trials, the required mix was found. This consisted of 19 pints of water, ½ cu. ft. of sifted washed sand, and ½ cu. ft. of Portland cement, with a pipe spinning time of 12 min.

It was found that using this mix, the cement lining had set sufficiently to allow careful handling for the last process, and for stacking purposes. The processed pipes were stacked in the open for 24 hours, with an ambient temperature of approximately 85°. One of these pipes was subjected to very drastic treatment such as dropping from a height of 7 ft., rolling, etc., and no damage occurred to the lining, in fact, to break the lining away from the bore of the pipe, the pipe had to be mechanically damaged by a sledge-hammer.

As a matter of interest the costs of cement lining of pipes worked out as follows:—

4 in.	...	9d. per ft. run.
6 in.	...	10d. per ft. run.
9 in.	...	11d. per ft. run.

This, of course, is using local labour, and it does compare favourably with local commercial prices.

The labour force to operate the plant was as follows:—

Blacksmiths 2	Mason 1	Improvers 6
Welder 1	Painter 1	Labourers 6
	Turner 1	

This appears to be large, but in view of local conditions it was not considered excessive.

The estimated speed of preservation was 500 ft. run of piping per day, the size of the piping was from 4 in. to 9 in. The maximum length of piping that could be preserved was governed by the distance between the support belts of the spinning rig, and in this case was 25 ft., therefore the maximum length of pipe that could be preserved was 30 ft.

The conclusion reached is that the design and manufacture of this type of equipment is not beyond an Engineer Base Workshop.

This article was written in 1954 and the author left the station shortly after production had started.

MEMOIRS

MAJOR-GENERAL A. BROUGH, C.B., C.M.G., C.B.E., D.S.O.

(The following account of his career has been prepared from notes left by General Brough.)

ALAN BROUGH was born on 20th March, 1876, at Sialkot in India, where his father, Captain (later Colonel) W. R. C. Brough, was serving in the R.H.A. Two of his uncles, Colonel J. F. Brough and Lieut.-General W. C. F. Gosling, were also Horse Gunners, so it is not surprising to hear that young Alan started riding at the age of 2, and hunted regularly for most of his life.

He was educated at Cheltenham, and passed into the Shop in 1892 at the age of 16, being sixth in his batch. He was commissioned in the Corps on 15th March, 1895, passing out fourth of his batch.

While at Chatham he played Rugger for the Corps and for Blackheath "A", and also rowed, being in the winning boat for the Batch fours.

In 1897 he was posted to India, first to Madras and then to Bangalore, but after a few months he was transferred to the P.W.D. Railway Branch, and was employed on the East Coast Railway in the central part of Madras province, on a portion of the line between the Kistna and Godaveri rivers. Major W. V. Constable, R.E., was at that time manager of that line.

After a number of small location jobs during the following year, including the location of a line from Kohat to Thal on the N.W. Frontier, he was posted in 1903, with Captain G. F. F. Osborne, R.E., to plan a new line, 380 miles long, to join the Bombay Baroda and Central India Line near Rutlam to the Great India Peninsula line at Delhi. The alignment included the difficult crossing of the Darah Pass where two parallel lines of hills, only a mile apart, cut straight across the general line. This necessitated heavy work with embankments fifty to sixty feet high, a cutting 35 ft. deep, and a viaduct of fifteen spans of 30-ft. arches, built on a curve of 4 deg. radius. Brough's layout of this portion of the line, which he was able to do without the necessity of any tunnel, is probably one of the finest pieces of railway alignment in India. Besides doing the alignment, Brough carried out the construction work as well, and the line was opened in May, 1908.

After a spell of leave in the U.K. Brough was posted as a Junior Government Inspector of Railways in the Lucknow area, which he held till 1912, when he returned to the U.K. to do a refresher course at Chatham.

On his return to India, after he had a short spell at Roorkee, he was again posted as a Junior Government Inspector of Railways, this time with the East India Railway.

After the outbreak of the 1914 war he was sent home with about seventy other R.E. officers in October, 1914, and two months later he was posted to the 55th Field Company, R.E., with the 7th Division in France. In March, 1915, the Company was in the first battle of Neuve Chapelle. It was in this battle that the bad mistake was made of attaching Sapper sections to infantry battalions in the attack. These sections could not be allotted any proper R.E. tasks, but suffered heavy casualties, and there was great difficulty in collecting them together after the battle.

The 55th Field Company had a hard time, as on several occasions when the division was withdrawn for a rest, the Sappers were lent to other corps for work. So it was when working for the V Corps the Company was involved in the first gas attack by the Germans on Ypres.

After this there followed a series of engagements and moves, including an attack on the Fromelles Ridge, work along the La Bassee Canal, and preparations for the battle of Loos. Just before this battle the 55th Company was attached to the Guards Division, and Brough took over as acting C.R.E. for Colonel Vanreenan, who had gone sick.

In February, 1916, they were back again in the Ypres sector, but moved south to Beaumont Hamel in August, and after various vicissitudes during the following twelve months, Brough handed over the divisional engineers in July, 1917, and was appointed Deputy Director of Transportation with the temporary rank of Brigadier-General. In this position he had to deal with many transportation difficulties during the big German attack in March, 1918, and our own subsequent advance later.

In September, 1918, Brough was ordered to Mesopotamia for transportation duties there, but by the time he arrived the Turks had been defeated, and he then went through Persia to the Caspian Sea to repair and run the Baku-Batum line. A year later, in November, 1919, he was attached to the British Military Mission with General Dennikin in South Russia. Here he had many narrow escapes from capture by the Bolsheviks, but kept going in the Crimea until November, 1920, when the Mission was withdrawn, and Brough then managed to get the Government of India to agree to his having two years' furlough.

In December, 1922, he was appointed Commandant of the Railway Training Centre at Longmoor, where he remained till the end of 1925. He was promoted Colonel early in 1926, and placed on half pay until appointed A.D.F.W. in F.W. 9 branch which dealt with stores and equipment. The D.F.W's. branch was shortly afterwards put under the Q.M.G., but Brough remained under the M.G.O. to deal with Signal and R.E. equipment.

In 1931, he was promoted Major-General, and after a further period on half-pay, he was appointed Director of Mechanization at the War Office in 1932, and held this appointment until he retired in 1936. Brough describes this period as a most unhappy one, as he could not get any decisions as to requirements either for tanks or wheeled vehicles, and had considerable difficulty over the development of any suitable form of anti-tank gun.

He was seriously ill for a time in 1935 and again in 1936, and was very glad to retire on 23rd June, 1936.

He was appointed a Colonel Commandant R.E. in August, 1939, and was the Representative Colonel Commandant in 1941. He died on 24th August, 1956.

A friend writing in *The Times* says:—

"Not only was General Brough a great engineer but his endeavour was always to teach his assistants all he knew himself, and in this his patience was unbounded. He was also a thoroughly good sportsman, an absolutely fearless rider and a most charming personality. There was no game which he could not play and play well, and his knowledge of horses and Shikar was far above the ordinary.

"I well remember, when I was a youngster fresh from home and green to the game of Shikar, and big game shooting, Brough used to impress on me that, in the pursuit of dangerous big game, there were three tenets which one should always bear in mind and endeavour to live up to.

"These were:—Never ask anyone to incur a risk which you would not willingly take yourself; unless it be absolutely necessary, do not take long shots at game which might possibly result in wounding and consequently suffering to the animal, but stalk it fairly to within decisive range. If the animal wins in this contest of wits and makes off, admit your defeat and let him go; if you be unfortunate enough to wound an animal, it must be followed up until it can be mercifully dispatched, and in following up wounded dangerous game, never forget that you are personally responsible for the lives of those with you. It is essential, therefore, that you must always be in the best position to protect them with your rifle ready for instant use.

"These three tenets sum up, I think, in a few words the spirit of General Brough—a great engineer, a true sportsman and a sahib. Few indeed came up to his standard and none surpassed it."

C.C.P.

BRIGADIER-GENERAL SIR JAMES EDMONDS, Kt., C.B., C.M.G., D.Litt. (Oxon)

A LITTLE more than a year ago there died Major-General Sir John Capper, aged 93, the "father of the Corps" and a most able officer. Now we have to mourn the loss of his successor in the Corps title and less than a month his junior, Brigadier-General Sir James Edmonds, who died on 2nd August, 1956, at the age of 94, and again an outstanding officer. In his very varied career he did indeed "fill the unforgiving minute with sixty seconds' worth of distance run", and up to the end was in good health with his great brain and amazing memory as alert as ever.

James Edward Edmonds was born on Christmas Day, 1861, at 19 Marlborough Road (now 20 Marlborough Place) in St. John's Wood, London: an oak tree was planted in the garden to mark his arrival and is at the moment in full leaf. He told the writer that he well remembered being taken for walks by his nurse through the lanes to Hampstead. He was the son of James Edmonds, architect, lawyer, and timber-merchant, and Frances Bowler of Walcot in Somerset.

He went as a day boy to King's College School in London and took several of the class prizes during his time there: he also excelled at running, swimming and diving, and was quarter back in the Rugby XV. Languages came easily to him, learnt at the breakfast table from his father—the habit having descended from father to son from his ancestor Sir Thomas Edmonds, French Secretary to Queen Elizabeth I. He spent many holidays abroad, especially in Germany: he later became the best German scholar in the Army.

Edmonds passed direct from school into the Royal Military Academy in 1879, top of the list. He passed out first, was Senior Under Officer, and won the Pollock Medal, the Sword, and several prizes, including those for German and Italian.

At the S.M.E. he was posted to the 11th Field Company, commanded by Major J. C. Tyler, under whose guidance he spent his leisure in sailing, rowing and hunting and the newly-invented lawn tennis. His later skill at pool got him his first nickname "Theodolite".

Asked in 1884 whether he preferred to go to Bermuda or to the Submarine Mining Service, he chose the latter and went to the 33rd Company at Malta, and in 1885, owing to a Russian war scare, took the Company to Hong Kong, remaining in command of it till he left in 1888. During these three years he had a Chinese and a Japanese teacher, and became conversationally fluent. The American consul in Hong Kong had interested Edmonds in the Civil War, in which he had fought: so Edmonds got leave to return home via America. He visited many battlefields and West Point, and had talks with several survivors, including Generals Sherman, Schofield and Hancock.

Posted to the 39th Submarine Mining Company at Chatham he was made Assistant Instructor in Submarine Mining, and learnt to play golf on the old St. Mary's links. Promoted Captain in 1890 he became Instructor in Fortification at the R.M.A. until 1895, which he thoroughly enjoyed. His leisure was spent in travel, learning more languages including Russian, and working for the Staff College. Incidentally he got 99 per cent marks in the promotion exam to Major, treating it as a gallop before the race for the Staff College.

In 1895 he passed first into the Staff College, Sir George Macdonogh, R.E., being second: Haig and Allenby were also successful that year. It was here that he got his other nickname of "Archimedes". In this same year he married Hilda, daughter of Rev. M. Wood: she died in 1921, and he is survived by an only daughter, who married J. P. Sandison, late Sudan Political Service.

After the Staff College the D.A.G. R.E. grabbed Edmonds and sent him to Jamaica, where he found yellow fever raging; he escaped this, and visited the theatre of hostilities in the American-Spanish War in 1898. After a go of dysentery in 1899 he came home on sick leave and never returned to Jamaica.

The South African War broke out in October, and Edmonds joined the German section of the Intelligence Division under Major-General Sir John Ardagh, R.E. After organizing a secret service section (hitherto non-existent) he went with Ardagh to South Africa, as advisers to Kitchener on matters of international law in war, being left in charge when Ardagh came home in 1902. At the end of hostilities he was lent to the S.A. Civil Government, under Milner, to complete and clear up his work.

Edmonds returned to England in 1904 via the coast of East Africa, Egypt, and Greece, and rejoined the Intelligence Division to deal with the Russo-Japanese War. It was during this period of 1904–1910 in the Military Operations Branch that he managed to complete, with his brother-in-law, W. B. Wood, his *History of the American Civil War*, which became a textbook in the U.S.A. He was promoted in 1907 to take charge of M.O.5 (later called M.I.5), and, after convincing the Committee of Imperial Defence of the German network of spies in the U.K., organized our counter-espionage system, which under his successor, Sir George Macdonogh, was so successful in 1914–18. He prepared various forms of censorship, the completion of codes, the Double Playfair cipher, and was on the committee which first issued wireless licences. While in M.I.5 he wrote, with Professor Oppenheim of Cambridge, the official manual *Laws and Usages of War*. His summer leaves were spent with troops, as an extra staff officer, during training on Salisbury Plain.

In 1911 Edmonds became G.S.O.1, 4th Division, which became a very highly trained Division. As his G.O.C., Major-General Sir Thomas Snow, put it, "You provided the brains, I provided the ginger". In the spring of 1914 a go of ptomaine poisoning, on top of training a division scattered between Colchester and Dover, almost broke him down and he asked for a period of rest on half pay. Snow coaxed him just to tackle "our last manœuvres together", which proved to be the 1914 war.

The 4th Division was early in the field in France, but Edmonds was far from fit and broke down from overwork and want of food and sleep during the retreat from Mons. He was sent to G.H.Q., and served under the Engineer Adviser (later E.-in-C.) Brigadier-General Fowke (later Sir G. Fowke, Adjutant-General) until the end of the war, finishing as Deputy E.-in-C. under Sir Gerald Heath. He was charged with certain Engineer activities, and in addition his advice was constantly sought by the General Staff and Intelligence Branches. Had his health been stronger he would without doubt have become C.G.S. of one of the armies. He had the possibly unique distinction of being mentioned in Sir John French's first Despatch and in Sir Douglas Haig's last.

In 1919, with Haig's approval, he succeeded Major-General Sir Ernest Swinton, R.E., as Director of the Historical Section (Military Branch) of the C.I.D. On leaving the army in France he received a copy of a letter, signed by Haig, saying "he had performed invaluable service in the collection of Engineer intelligence and the organization of defences. He had also been of material assistance to the General Staff by his thorough knowledge of Germany, the Germans, and international law, and had always carried out his duties to my entire satsifaction." He remained with the Historical Section (transferred in 1939 from C.I.D. to the offices of the Cabinet) as author, Director of Military Branch, and (from 1939) Secretary—compiling or editing the volumes of the Official Military History of 1914–18, for a period of thirty years, until May, 1949, by which time he was 87. He had a clear and concise style, knew all the chief actors, and had a great knowledge of warfare and a wonderful memory: his linguistic abilities enabled him to read the pick of the French and German writers on the war. Thus his wise judgement and sense of proportion helped him to produce a great history, which of its kind has never been excelled. After his retirement he wrote *A Short History of World War I*.

During his thirty years in London he served on the Council of the Institution of Royal Engineers and was its President for four years. He served on the publication committee of the R.U.S.I.; on the Committee of Management of St. Peter's Hospital, Covent Garden; on the Board of Governors of King's College School; as Chairman of Council, Army Historical Research. He was created C.B. in 1911 and C.M.G. in 1916, and was knighted in 1928: he received the Legion of Honour and other foreign decorations. Oxford University gave him the honorary degree of D. Litt., and he was awarded the Chesney Gold Medal by the R.U.S.I.

He was essentially a happy man, and said of himself that he had a contented mind, with means to travel and buy books: he only needed, and obtained, interesting work and, remembering his Confucius, "peace and obscurity". He did not suffer fools gladly, and could be frank and on occasion outspoken in his criticisms: but his own standards were high, and those who gained his confidence and friendship gladly gave him their affection and admiration. When offered an honour at the end of his career, he asked for permission to go on using the War Office library. He had many good friends, and looked back without any regret on a long life enlivened by valuable work and ending with his great faculties still unimpaired. In his modest summing up he quoted Schiller: "Ich habe genossen das irdische Glück, Ich habe gelebt und geliebet! —I have enjoyed happiness on earth, I have lived and I have loved."

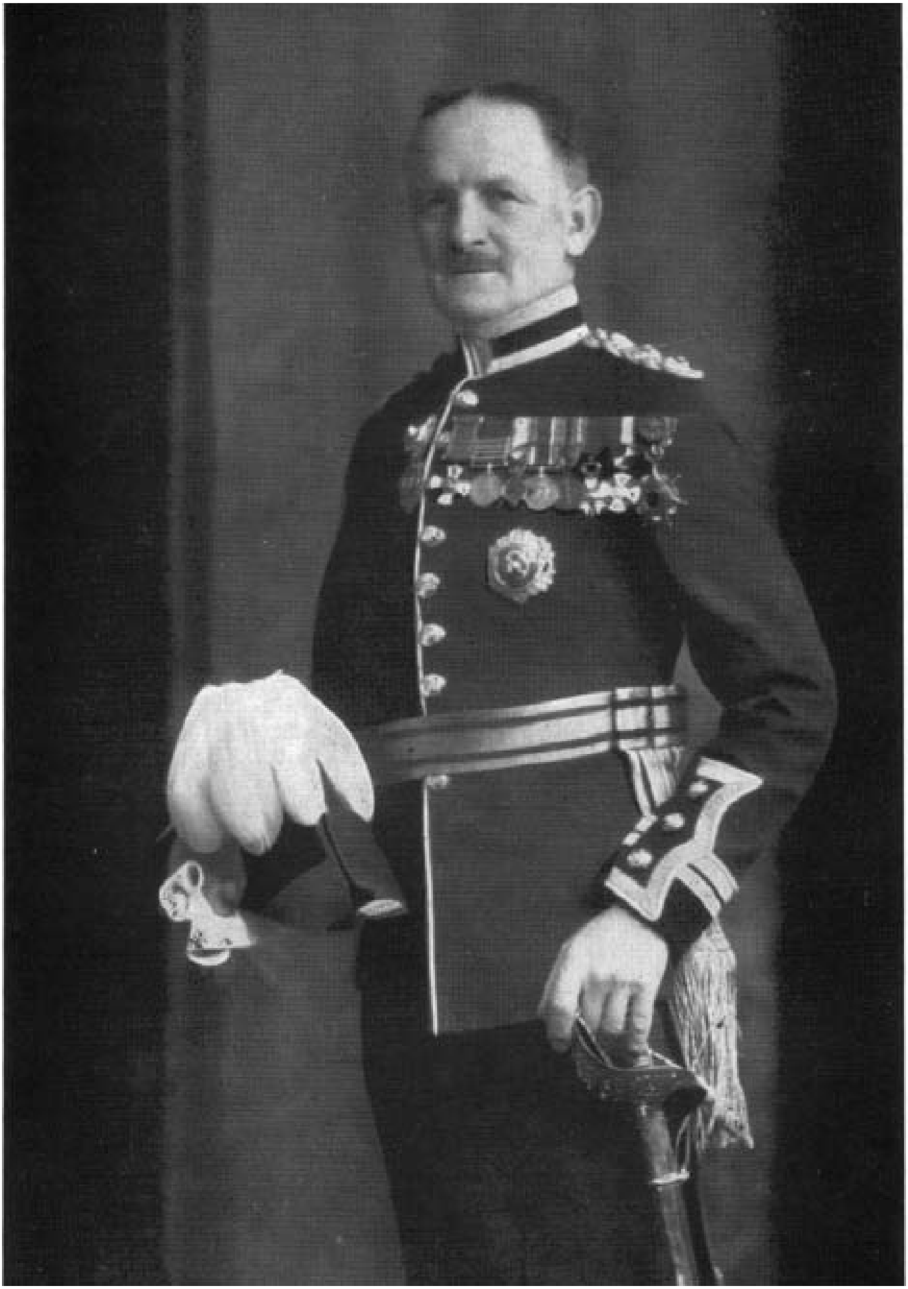
E.E.B.M.

COLONEL S. F. NEWCOMBE, D.S.O.

STEWART FRANCIS NEWCOMBE died in Oxford on the 18th July, 1956, after a long illness. Educated at Christ's Hospital and Felsted, he passed first into the R.M.A. Woolwich, with the very rare distinction of 100 per cent marks in mathematics. On passing out he was awarded the Sword of Honour and commissioned in the Royal Engineers on 23rd June, 1898. From the S.M.E., Chatham, he went out to the South African War, joining the 29th Fortress Company at Cape Town in February, 1900.

His long contact with the Arab countries dates from May, 1901, when he joined the Egyptian army with which he served until 1911. His work lay largely in the Sudan, mainly on surveys for new railways in the Wadi Halfa, Blue Nile, and Atbara areas. From 1911 to 1913, following short spells at the War Office, he was again employed on survey work in the Sinai Peninsula, in Palestine and with the Belgian Congo Boundary Commission, being seconded from the 10th Railway Company, R.E., Longmoor.

Brig-General Sir James Edmonds Kt, CB CMG DLitt (Oxon)



Colonel S F Newcombe,DSO

In the first World War Newcombe had two short periods in France in 1914 and 1915; followed by Gallipoli, where he was C.R.E. 2nd Australian Division and was awarded the D.S.O. But he was soon back in Egypt, with George Lloyd, Aubrey Herbert, Leonard Woolley and T. E. Lawrence. This party became known as "the Five Musketeers".

After the Arab Revolt, Newcombe headed the British Mission to the King of the Hejaz. T. E. Lawrence had preceded him there and had already established good relations with the Arab leaders. Typically, Newcombe promptly waived his own seniority and asked how best he could help. After the capture of Wejh, the demolition raids on the Hejaz railway were largely his personal work. They were masterly, in that they were not intended to "kill" the railway completely. A considerable enemy force was thus permanently employed in guarding, repairing and operating the line in return for a mere trickle of traffic which was probably allowed to pass deliberately.

In June, 1917, Newcombe was appointed G.S.O. I., E.E.F. In September he proposed, and Sir Edmund Allenby agreed, that he should take a small party through the desert, well east of Beersheba (country which he knew well from earlier surveys), to raise the Bedouin against the Turks and to cut the Hebron road after Beersheba was captured. In due course, with seventy camelry and a few Arab scouts, he cut the enemy telegraph line to Jerusalem and blocked the main road north of Dhahriye for some forty hours, causing the enemy to move considerable forces east of Sheria just at the critical time. Newcombe dispersed with loss the first attack by a hundred Turks. Next day, much larger Turkish forces under a German officer attacked from north and south. With twenty men killed, many more wounded, most of his machine guns disabled, and no other force dependent on him, Newcombe surrendered.

The effect of Newcombe's effort in Hebron is mentioned in "Yilderim" by the German Obergeneralarzt Steuber. The British *Official History* remarks that "Newcombe's force had an effect altogether disproportionate to its size".

While a prisoner of war in Constantinople early in 1918, Newcombe met a French lady, Mlle. Elsie Chaki. Shortly afterwards, when he was moved to the P.O.W. camp at Brusa on the Asiatic side, about seventy-five miles from Constantinople, it was she who arranged for a fishing boat and crew to wait at Moudania, the port for Brusa. In due course Newcombe made his escape in disguise. He covered the twenty miles to Moudania by night and located the boat. The two Greek fishermen sailed with an unusually big Arab passenger, but only daylight at sea showed that he also had unusually blue eyes. It took forty-eight hours to cross the Sea of Marmora.

In Constantinople, Newcombe went into hiding. At the request of the New Party in Turkey, he drafted peace proposals. Raouf Orbay, later to become Prime Minister of Turkey and then Turkish Ambassador in London, took the proposals (and Newcombe) to sea. They were picked up by H.M.S. *Liverpool* and taken to Mudros.

Newcombe married Mlle. Chaki in London in April 1919.

After the first World War he served in turn in Syria, Ireland, Palestine, England, the British Army of the Rhine, and Egypt. In Syria he made what was probably the first of all aerial surveys and he was awarded the Montgomerie Prize for an article published in the *R.E. Journal* in 1921 on "Contouring by the Stereoscope on air photos". He went to Malta in 1929 as Chief Engineer, retiring in 1932.

As the result of his contacts with the Anzacs in the first World War, Newcombe later did much to promote emigration of British ex-servicemen to Australia which he visited in 1923. From the first World War to the day of his death, he also proved a remarkable friend to Arab and Jew alike in the Near East. His sound constructive advice was acknowledged at the time, and later in numerous letters received by his family from both parties after they learned of his death.

In 1940 and again in 1943, when well over 60, he undertook with success two political missions to Baghdad, travelling by the Mediterranean route.

For most of his retirement he was an active member or official of the Palestine Exploration Fund and also of the Royal Central Asian Society, in both of which he was deeply interested.

Throughout his life Newcombe hated pomp and pomposity. He was unassuming, accessible, sound and scrupulously fair, if stern, in his judgements and advice, to men of all races and of all ranks. Those of his own Corps and others who served above or below him in war or peace, will always remember his driving power on any job, his audacity and boldness in conception and execution, his wonderful capacity for friendship and that love of fun and unfailing cheerfulness which merely increased when difficulties arose. His doctors and nurses were greatly impressed with this right up to the very end. The Arabs had once likened him to "fire which burned friend and enemy equally". This was so in hospital, where he persisted to the day of his death in working on ideas in which his representations must be generally accepted one day, if at present ahead of their time.

Mrs. Newcombe, his son and his daughter survive him. To them will be extended the deep sympathy of all who knew Stewart Newcombe.

I.S.

BOOK REVIEWS

HISTORY OF THE SECOND WORLD WAR
VOL. V. GRAND STRATEGY

By John Ehrman

(Published by H.M. Stationery Office. Price 42s.)

This book tells the story of the planners during the first year of the Allied offensive. How fortunate we were, and indeed so were the Americans, in the magnificent service given by the British planning machine; the small staff of outstanding men whose work behind the scenes made possible the immense task of leadership and provided the pattern and the means for victories in the field.

Grand Strategy Volume V deals only with the central direction of affairs during this year of great events and provides a background for the other volumes devoted to the invasions of Italy and N.W. Europe, to the S.E. Asian campaigns, to the War at Sea and to the Strategic Air Offensive. It starts with the Allied blueprint of offensive strategy (Quebec 43), the fruit of an historic phase of collaboration between Allies determined to find the best solution to a common cause and prepared to be flexible in negotiation. It describes the first year of execution, a year of great events which raised complex issues tending to distort the planned pattern. These were not resolved without difficulties and disputes which are frankly discussed in proper perspective to the larger areas of consent and to the close co-operation that was maintained throughout.

In directing the master plan it was the details and finishing touches, the supporting operations and diversions, which raised difficulties, the major priorities were common ground. There was at this time no preponderating allied superiority and the paucity of resources, and more acutely the means of transporting them, was the root cause of dissensions at the centre and of British disappointments in theatres. American might was increasing apace and American material was needed to keep British Forces in the field; the British effort, on the other hand, passed its peak in 1943 and was declining. It was therefore inevitable that negotiations tended increasingly to be swayed by the American viewpoint.

This authoritative military history gives a balanced and unbiased account of why decisions were made, how the Supreme Commands were evolved and what sort of planning problems had to be resolved. For reasons of space and sequence, the impacts at the centre of logistic and engineer achievements and problems are briefly recorded, these should not be underestimated by students of war planning.

It is a fascinating study, but the terms of reference exclude the highlights; the sparkle of battle, the twists of diplomacy, the clash of personalities and the refreshment of anecdote. Other books which tell the same story are more fun to read. G.N.T.

MUTINY AT THE CURRAGH

(Published by Macmillan & Co. Ltd. (London) Price 18s.)

It seems almost incredible that such things could have happened within the lifetime of many readers. Yet in 1913–14 a private army was raised in Ulster to defy the will of Parliament. It drilled openly. It was armed by dint of daring gun-running, organized by a man who subsequently was awarded the C.B.E. It was supported vehemently by His Majesty's

Opposition both in Parliament and in the country. Field-Marshals and retired Admirals rallied to its support. The Director of Operations at the War Office backed it actively from behind the scenes. And most of the officers, including its commander, of the 3rd Cavalry Brigade preferred to resign their commissions rather than ride to oppose the private army.

At the risk of over-simplifying the situation it may be described as follows. The Liberal Government (under Asquith) was determined to bring in a Bill giving Home Rule to Ireland. The Opposition considered it wrong that Protestant Ulster should be taken from under the aegis of Westminster and put under a predominantly Roman Catholic assembly to be established in Dublin. The Ulstermen were prepared to resist and were backed by H.M. Opposition. As the Bill approached the stage of becoming law the Government foresaw breaches of the peace amounting to civil war. The Services were called upon in Aid of the Civil Power. With notable exceptions the Government's intentions were handed down in such uncertain terms that many officers could not see which way their duty lay. From this confusion of thought arose the "mutiny"; and as a result of the "mutiny" the C.I.G.S. was removed, the Commander-in-Chief in Ireland was suspended and the Secretary of State for War resigned. What exactly would have happened had World War I not broken out is an unanswered question.

Hardly a character in this drama was less than a "star". The politicians included Asquith, Churchill, Seely, Bonar Law, and Carson. Lord Roberts, Henry Wilson, Arthur Paget, French, Gough, and many other well-known soldiers played their parts. Erskine Childers and Roger Casement flit across the scene. Few men seem to have acted entirely wisely. Some acted foolishly and impetuously; some with vacillation and hesitation. One man alone seems to have matched up entirely to the occasion: H.M. King George V, a new monarch, whose wisdom and balance were not yet recognized.

Tempers have now cooled down and judgements are less critical. Many of those who were in the thick of the turmoil are either still alive or have left written records of their thoughts, words and deeds. From this mass of evidence Mr. Ryan has distilled an eminently readable and balanced book. It has many lessons for the soldiers. If one stands out more than others it is this: Action in Aid of the Civil Power is always distasteful. There is a natural tendency for orders to lack definition. Yet any lack of definition above leads to positive vagueness on the lower levels, and from this confusion is inevitable. Any doubt as to the legality of the orders given is an added difficulty involving everyone. Any officer, therefore, from the highest to the lowest must decide in his own mind whether the order he receives is a legal one. If he deems it to be legal he must obey it resolutely, and insist upon his subordinates doing the same. If he deems it to be illegal he must refuse to obey and take the consequences. There is no middle course. The one thing to avoid, if in doubt of the legality of the order, is to "water it down" so that subordinates have doubt what to do. This is what happened in this incident at the Curragh. As the orders trickled down the chain of command they seemed more and more to offer a middle way; and the officers of the 3rd Cavalry Brigade took it.

The book is a story of sincere and passionately held convictions, hot tempers, violent words and firm action on the one hand and vacillations, doubts and uncertainties on the other. This alone would make it interesting; but the characters are well drawn and the personalities are famous men. That makes the book fascinating.

M.C.A.H.

THE STORY OF THE GUARDS ARMOURED DIVISION

By Captain the Earl of Rosse, M.B.E., and Colonel E. R. Hill, D.S.O.

(Published by Geoffrey Bles, London. Price 25s.)

A short history of the Guards Armoured Division by Major-General G. L. Verney, D.S.O., M.V.O., appeared in 1955 and was reviewed in this *Journal* last December. This second history, which is the official one, is considerably longer and contains far more detail than its predecessor. For the general reader, the extra detail is somewhat difficult to follow, since the maps are of small scale and there are no supplementary sketches. Yet those who fought with the division will welcome the carefully collated and spirited descriptions of the fierce local actions of the liberation campaign, which the history supplies. Of these, the fiercest and most important are probably those of the Nijmegen–Arnhem battle, during which the division forced its way for nearly sixty miles along a single causeway and across eight large waterways. This great feat of arms has not perhaps received all the attention which it merits and it is good that a more detailed record of it is now available. Appendix 5 is a most able, short description of the group system of administration as worked by the Guards Armoured Division. Fourteen excellent photographs, some of which are published for the first time, embellish the book. General Verney's history is perhaps more professional: this one is far richer in incident and human interest.

B.T.W.

THE DECISIVE BATTLES OF THE WESTERN WORLD—VOL. 3

By Major-General J. E. C. Fuller, C.B., C.B.E., D.S.O.

(Published by Messrs. Eyre & Spottiswoode, 1956. Price 45s.)

Volume 3 of *The Decisive Battles of the Western World* completes a study of war which in grandeur of outline and wealth of learning has never been surpassed. This last volume is even more enthralling than its predecessors, since it covers the prodigious events of the last fifty years, which have so profoundly altered the political balance of the world. The views of perhaps our most eminent military historian and philosopher on this stormy period cannot fail to throw a new light on agonies and perils to which few can look back without a shudder.

General Fuller more than fulfills our most sanguine expectations. He attributes the tensions, which gradually developed between nations during the nineteenth century, to the impact on them of the Industrial Revolution. Getting firmly into the saddle with the American Civil War, he rides this theme with masterly skill right through the book, which ends with a sphinx-like riddle on the same subject.

Like all historians whose books are worth reading, the General writes with a certain prejudice and ferocity. Stonewall Jackson, who years ago in the days of Henderson could do no wrong, now stands condemned for being a difficult subordinate and for ceasing all military work on Sundays. Sherman is acclaimed as the modern champion of total war in that he set out "to make war terrible beyond endurance." Moltke the Elder is blamed for the aloof conception of generalship, which Swinton made familiar to British soldiers in his story of the fly-fishing generalissimo in the *Green Curve* and which reached its final absurdity at Suvla Bay in 1915. The book is full of similar characteristic utterances. Yet his criticism of Roosevelt and to a lesser extent of Churchill is severe and often unjust.

In the maelstrom of a life and death struggle, even a very great statesman constantly has to do as best he may: he cannot have the prescience of a god. The fact is that General Fuller's rather crotchety genius is analytical rather than constructive. His sharp eye darts on to failures and mistakes, which his merciless pen records, but his judgements are apt to be wanting in warmth and humanity.

Nevertheless it is good that a detached and severely critical historian of such distinction should thus review what he believes to have been the errors of the past, particularly those relating to the higher conduct of war. Indeed one of the chief lessons of this final volume is that statesmen made far more mistakes than their military leaders. Under modern conditions therefore all men in authority require to read and re-read the campaigns of the great captains and closely to study the supreme art of relating battles to policy.

The three volumes of *The Decisive Battles of the Western World* now stand available to all. Those who are wise will add them to their libraries before the books go out of print—which seems probable.

B.T.W.

THE DEVICES OF WAR

By NORMAN KEMP

(Published by Werner Laurie, Doughty Street, W.C.1. Price 18s.)

This book is a popular account of some of the many war inventions and their inventors. It is hardly to be called a representative selection. The wonders of electronics are not mentioned, nor is the supremely successful Bailey bridge, which was used in campaigns all over the world. Most of the devices, such as Pluto, Fido and the Mulberry Harbour, relate to the second World War, but one very notable one dates back to 1915. This was the synchronizing gear for firing machine guns through the propellers of aircraft without hitting the blades. It brought Constantinesco, its inventor, £250,000, before which other awards for war inventions pale into insignificance. Only two of the other inventors mentioned got into five figures and one of them was that picturesque person, Lieut.-Colonel L. V. S. Blacker of the Guides, who has rounded off an adventurous life by becoming expert in the development of anti-tank and anti-submarine weapons.

The stories of the various devices are well told and make good reading. In World War II Winston Churchill was personally interested in finding new remedies for new evils, so that on the whole inventors were treated with greater consideration and more respect than ever before in our military history. The rich harvest of inventions which resulted helped much in the winning of the war. So let us cultivate our inventors.

B.T.W.

HYDRODYNAMICS

By DRYDEN, MURNAGHAN, and BATEMAN

(Published by Dover Publications Inc., New York. Price $2.50)

This is a comprehensive study of the whole field of classical hydrodynamics produced by a special committee of the National Research Council of the National Council of Scientists of the U.S.A. It is an encyclopaedic textbook and carries a degree of authority which gives it great importance in its field. It is of course a book for the expert, or would-be expert, rather than the general reader, and requires a sound mathematical knowledge for its understanding.

It is divided into four parts of which the first deals generally with the Physics of Fluids and Classical Hydrodynamics and contains a general survey of experimental aerodynamics, the hydrodynamics of a perfect fluid and the general physical properties of a viscous fluid.

The second part deals at some length with the motion of an incompressible viscous fluid, the third with turbulent flow and the fourth with compressible fluids.

The theories outlined and discussed in the book are applied to a wide range of practical cases. Aerodynamics and flow in pipes naturally take a prime place but among the subjects covered are lubrication, the transportation of material by rivers, flow in channels, the transfer of material, heat and momentum by eddy motion, and, in fact, the whole hydrodynamic field.

There are thorough lists of references at the end of each chapter, and these should be of the greatest value to anyone wanting theoretical guidance on even the most obscure branches of this subject.

J.E.L.C.

THE DESIGN AND CONSTRUCTION OF ENGINEERING FOUNDATIONS

By F. D. C. Henry

(Published by E. & F. N. Spon, Ltd. Price 63s.)

The opening chapters (about one quarter of the volume) deal fully with the question of site investigation, geological formations, the grading and strength of soils and the problems connected with permeability and stability of slopes. It is not until after the reader has been made fully aware of the problems connected with the soil below foundations, that he is led on to the ways and means of overcoming the defects in, or utilizing to good effect, the soils upon which he must build. Both field and laboratory tests are illustrated and described.

The following chapters are a full and authoritative review of present-day design and construction practice in foundation engineering, both here and in the United States. Chapters are devoted to the design and construction of normal types of foundations, such as individual and strip footings, rafts for buildings, and foundations for bridge and retaining wall abutments. These are all fully illustrated and analysed. In addition a chapter describes the effects of mining subsidence, and here the author makes suggestions as to how various structures should be designed so as to accommodate differential settlement or lateral movement of the foundations. For reservoirs in this type of country the author recommends a prestressed concrete construction.

Two chapters deal with piling problems; the first with cofferdams and caissons and the problems associated with compressed air workings; and the second with the design and construction of bearing pile foundations. An analysis of pile groups and the effect of the proximity of one pile on its neighbour is well covered, as too is the question of raking piles when considered as part of a load-bearing group.

A final chapter covers underpinning; and for those interested in it, the movement of complete buildings from one site to another.

The book is well written, well illustrated and very fully referenced. A series of appendices considers the mathematics appertaining to the design of unsymmetrical sections in steel and concrete, whilst the final Appendix G gives 100 problems in foundation design for the student to study. Answers are provided.

W.A.H.

TECHNICAL NOTES

THE MILITARY ENGINEER

JOURNAL OF THE SOCIETY OF AMERICAN MILITARY ENGINEERS

July-August, 1956

Practical Utilization of Atomic Power, by J. D. Anderson

The author is manager of the Schenectady Operations Office, one of the three Reactor Development Operations Offices of the Atomic Energy Commission. He was first employed on Atomic Energy work as an Army Officer with the Manhattan District in 1944.

In an interesting and well illustrated article the author outlines the rapid development of reactor technology in the practical application of Atomic Power to meet Service requirements. He stresses the value of this heavy expenditure from Services budgets in making economical atomic power for civilian purposes a reality far sooner than would otherwise have been possible.

He attributes this very rapid progress in the development of military power reactors to two main forces: First, nuclear power has a basic military application which cannot be met by any other means; and, second this need was recognized by a Naval engineer who pushed the development of submarine propulsion with a vigour and effectiveness that is making development history.

The first nuclear powered submarine, the *Nautilus*, on her first cruise, steamed 1,300 miles fully submerged at an average speed of 16 knots. This broke all previous distance records for fully submerged performance by a factor of 10. *Nautilus* returned to port, the first vessel ever to have travelled 25,000 miles without refuelling. The earlier transition from sail to steam is no more significant than the present replacement of steam or oil by nuclear propulsion. The present A.E.C. Naval Reactor Development Programme includes a series of reactors ranging in size from 3,000 to 40,000 shaft horsepower. The Navy has announced that by the early 1960's all new construction will be nuclear powered.

The author describes at some length his work at Schenectady in the development, construction and testing of the nuclear power plant for the submarine *Seawolf*, due to go to sea this year. Briefly, this power plant is quite different from that of *Nautilus* which uses water (under high pressure to keep it from boiling) as the primary heat transfer medium between the reactor and the steam generator. *Seawolf* uses molten sodium as its heat transfer medium. One of the basic problems in a nuclear power plant is to transfer the heat from the reactor fuel to the water in the steam generator at a high temperature so that reasonable steam conditions can be maintained at the turbine throttle. Certain liquid metals like sodium have advantages over water as heat transfer fluids and can be circulated at high temperatures, like 700° F. at atmospheric pressure, where water at such temperatures would for example require to be used at a pressure exceeding 3,000 lb. per sq. in. to keep it from boiling. Water at high temperatures is highly corrosive: sodium is not. Sodium, being a conductor, makes possible the use of the electromagnetic circulating pump which has no moving parts. Comparison of these two types of reactors will be possible from experience provided by *Seawolf* and *Nautilus*.

The article includes an excellent illustration of a model of the Army Package Power Reactor now under construction at Fort Belvoir and scheduled for operation in 1957. This 1,825 kW. generating plant will have a pressurized water reactor operating at a 10 megawatt power level and the primary circuit will operate at 1,200 p.s.i.a. with water leaving the reactor at 450°F. The steam generator will operate at 200 p.s.i.a. and 404°F. The A.P.P.R. has been designed for all components to be air transportable for rapid erection at remote sites. The usual heavy concrete biological shield has been replaced by an iron, water-filled shield with a considerable saving in weight.

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, June, 1956

London Airport

At present London Airport is probably the most up-to-date of the world's international airports. This contribution by two officials of the British Ministry of Transport and Civil Aviation describes briefly its development from an R.A.F. project, and sets out very clearly the essential features of the complicated electrical and mechanical installations involved. Navigational aids, airfield lighting and aircraft control are well described, and the care taken in functional planning is exemplified by the details given of passenger-handling and public amenities.

Automation, Men, and Machines

The author of this vividly-written paper, justifiably deploring the name "automation", concedes that its coining provided the catchword necessary to secure general acceptance of the idea of the replacement of the human machine-operator by automatic control, for the history of technology shows that, after the discovery is ready for the world, the world must be made ready for the discovery. Even so, there has been a time-lag of ten years since the end of World War II, when everything necessary for rapid development was available.

Automation differs from mass production or mechanization in that design is based upon the function performed by the machine rather than upon the creation of a particular end-product. Automatic control is essentially flexible, and it is therefore suitable for general manufacturing plants, by far the largest group. For this reason, the economic and social effects of displacing men from the factory floor are of supreme importance, and the need for educating management executives to appreciate new techniques and potentialities is apparent. This paper is a sane, straightforward exposition of the nature of automation and of some of its likely effects: it is worthy of a wider public.

Notes from *The Engineering Journal of Canada*, July, 1956

Cross-Suspension System

Kemano-Kitimat Transmission Line

The 49-mile long transmission line from Kemano to the aluminium plant at Kitimat was described in *The Engineering Journal* of April, 1953 (see *R.E. Journal*, September, 1953). At the end of January, 1955, an avalanche destroyed three towers in the section where the lines rise steeply over the Kildala Pass, bringing down the conductors which, though they remained intact, were short-circuited and severely damaged. Temporary repairs of the two circuits were carried out, in continuously bad snowfall, in nine and nineteen days respectively.

For the permanent relocation it was decided to suspend the transmission lines from two wire ropes crossing the valley transversely and yoked together on either side of the centre section. Because of site conditions, the system finally adopted has no symmetry. All four rope anchorages are at different elevations, the four wire rope lengths are all different, the four main conductor spans are unequal, and the end towers, forming part of the original layout, are at different levels. The complexity of calculations led to the use of a scale model to confirm stresses and distortions under various loading conditions, and this model disclosed an unsuspected resonance problem which might have led to disaster.

This is a most unusual engineering problem, and its practical solution is very interesting. The excellent photographs, illustrating the nature of the work and the extremely difficult conditions under which it was performed, enhance one's admiration for the organization which carried out the whole project in six months and four days from the decision to start work, and exactly eight months after the breakdown.

Notes from *The Engineering Journal of Canada*, August, 1956

Microwave Radio Project of the Trans-Canada Telephone System

A micro-wave radio system, spanning the Canadian continent from Nova Scotia to Vancouver, is to be completed by the middle of 1958. The TD-2 radio relay system, which has already been in use between Buffalo and Montreal for three years, provides six radio channels in each direction. Each channel can carry 600 high-grade telephone circuits or one network television signal, either black and white or in colour. Clear line of sight transmission paths are required between repeater stations, spaced at an average distance of 30 miles. Four separate antennae are needed at each repeater station, and the type mainly to be used incorporates a horn reflector about twenty feet high and eleven feet wide. The top surface of the horn is a section of a paraboloidal reflector, at the focal point of which the apex of the horn lies. This design has highly directional characteristics and provides a very narrow radiated beam.

Route selection and radio path testing are clearly described, and protection switching, alarm and control facilities and maintenance features are discussed. Some 160 repeater stations are required in all, many of them in remote areas and in widely differing types of terrain. Construction problems and techniques are summarized.

"Automating" the Engineer's Task

After an admirably simple statement of the function of automation, the author analyses normal engineering techniques and shows how electronic computers can be applied to perform lengthy routine sequences, particularly in the field of analysis and evaluation. Much interesting information is given in this short and eminently readable paper, which contains an amusing appendix illustrating the three main methods of solving a problem and concludes that man-made tools will never replace the engineer himself.

CIVIL ENGINEERING

Notes from *Civil Engineering*, April, 1956

A Novel Laminated Timber Roof Structure

A completely novel roof structure in both design and method of construction is described in this article on the laminated teak roof of the Rangoon Assembly Hall. The architectural merits of the arrangement which led to the choice of construction medium and general arrangement are discussed. The final conception of a Turtle back roof shell of laminated teak boarding supported only on two slender steel arches results in an interesting structure reflecting its highly functional design. The article gives the over-all size of the building as 153 ft. 4 in. × 93 ft. The shell proper is made from teak boards 4 in. wide by $\frac{3}{8}$ in. thick, laid in five layers with the planking running in different directions in each. Each layer is set in a synthetic rescorcinal resin. (Cascophen RS 216 M, developed by Leicester, Lovell, and Co. Ltd.) The layers were constrained to their final form by galvanized wood screws, which serve no structural purpose other than to hold the planks in position till the glue sets. Tests for durability were simulated by subjecting a test piece 12 ft. by 12 ft. to a maintained temperature of 115°F. which was sprayed every four hours for two hours at a time with water. The process was continued for four weeks with occasional temperature rises to 176°F. Splitting of the untreated wood under this action indicated the desirability of a protective covering.

The following treatments were tried:—

(*a*) Aluminium paint.
(*b*) Aluminium paint and Isovar (synthetic varnish).
(*c*) Isovar applied in two coats.

This proved the superiority of the last treatment for which the estimated life of the structure has been given as sixty-five years.

The Measurement of Dynamic Stresses in Structures

The dynamic effect of loads on structures has in most Codes of Practice been covered by empirical impact factors. The article reviews some of the instruments capable of experimentally arriving at the magnitude of peak stresses due to these dynamic loads.

In most cases the initial transient stress variation is followed by a periodic stress fluctuation which is removed by damping. The structural engineer is concerned with peak stresses. The mechanical engineer is concerned mostly in periodic stresses.

Early mechanical type instruments are discussed although it is pointed out that these have now given way to electric resistance strain gauges, in which the variations of stress are capable of being recorded by Cathode Ray Oscilloscopes. This permits reading of several gauges with apparently simultaneous traces. Electric resistance strain gauges are usually incorporated in a Wheatstone bridge circuit, with dummy gauges to compensate for temperature effects.

The author gives instances of how these methods have been successfully applied to ascertaining stresses in bridges, automobile frames, and cranes. The applications quoted in the article, however, mainly concern the effect of dynamic loads on the last type of structure, interest being centred on measuring strains in existing cranes to establish design criteria in future designs. The article includes circuit diagrams, reproductions of actual recordings made by the equipment described, and photographs of the cranes used in the trials.

Notes from *Civil Engineering*, May, 1956

Storm Damage and Protection North Kent Coast

The article reviews the work undertaken on the Northern Sea Wall which fills a gap in the natural defences from the sea between Reculver and Birchington. In times past an earthen wall was built landward of a shingle bank in this area. This accumulation of shingle has played a large part in preserving the earth walls from the full effect of wave action.

However, in recent times the wall has suffered damage with increasing frequency. In 1949 it was almost breached, and suffered extensively. A scheme was then prepared at an estimated cost of £300,000 to build a reinforced concrete wall along the crest of the old one. But before this could be undertaken, the wall was breached in two places with 700-yd. gaps during the storms of January and February, 1953. It is significant that these breaches occurred where the wall was least protected by shingle—difficulties in rebuilding were anticipated due to the weakness of the strata on which the Northern Sea Wall stands. This precluded rebuilding with a dense material such as concrete. The final form decided was a clay embankment approximately the same height of the original wall, protected by a flexible casing of concrete blockwork. The blocks are jointed with bitumen or cement mortar, depending on its location, and laid between a framework of reinforced concrete beams, which also carry a wave wall on the seaward crest. It was realized that the wall will probably be overlapped by waves during severe northerly storms, because of the limitation in height imposed by foundation difficulties. Results of experiments on scale models in a wave tank indicated that overlapping would be even more severe than estimated and the wall was correspondingly strengthened. The new scheme will cost approximately £1,740,000.

Use of Vibration for the Deep Compaction of Granular Soil

The method of improving the engineering properties of granular soils by simultaneously flooding them with water and vibrating them is described in this article. The method has been practised in Germany since before the last war, and has been successfully used for the following purposes:—

Reducing compressibility.
Increasing bearing capacity.
Reducing settlement under vibrating loads.
Reducing permeability.

The only material required additional to the equipment is aggregate and water; and the result is not affected by the height of the water table.

Interest has been focused upon the method by comparatively recent demonstrations before the U.S.A. armed forces.

The vibrating tool used in these tests is known as a Vibroflot. This is essentially a steel tube of 15 in. outside diameter within which a 200-lb. weight eccentrically rotated at 1,800 r.p.m. is the source of vibrating energy. The upper compartment contains a 30-h.p. 440-volt a.c. water-cooled electric motor. The water, electric cable and means of suspension are encased within a follow-up pipe. The operation of the equipment requires the discharge of water at the rate of 60 gal. per minute from jets at the bottom when penetrating, and from the top while compacting. The weight of the equipment including the follow-up pipe is 2 tons. Additional equipment required is a crane or pile-driving rig to suspend the equipment; a generator and pumps; and some means of providing aggregate to make up the surface at the point. Penetration is effected at the rate of three to six feet per minute and Compaction at the rate of 1 ft. in 40/60 sec. Compaction has successfully been carried out at depths of 30 to 45 ft. below the surface. A recommended pattern of penetration is in the form of an equilateral triangle with sides of 7 ft. 6 in. to 8 ft. The system is considered effective in soils containing 10 per cent clay; but is not effective in soils where the clay content is above 25: Photographs show the action of the vibrator and the consolidation achieved.

A Two-Storey Extension to an Existing Building

A novel method of adding two storeys to a concrete framed building is described in the article. The work was carried out on Waring and Gillows depository on Western Avenue. The essential novelty in the system is the precast concrete columns which have steel lattice connecting pieces at the beam junctions. This permits complete absence of concrete at this level in the column. Prestressed and precast beams with notches removed from their ends provide the interlocking bearings. This with *in situ* concrete provides the necessary continuity at these junction points. The system is clearly illustrated with photographs and diagrams, and is more akin to conventional steel frame erection than reinforced concrete construction.

Notes from *Civil Engineering*, June 1956.

Distribution of Deformation Method for the Construction of Influence Lines

The method described in this paper, due to Dr. C. V. Kloucek, enables the determination of influence lines for indeterminate structures to be carried out comparatively rapidly. The method is based on Muller-Breslau's principle which states that for any function such as reaction, bending, or shear, the influence line at any point of a structure is the same as the deflection curve obtained by allowing that function to act at the point considered so as to produce unit deformation. It is only necessary to draw the deflection curve of the structure; this presents no difficulty once the rotation at the joints is known. It is obtained directly by the distribution of deformations. The basic expressions by which this is done are given; but are not derived here. The method is illustrated by means of four worked examples which certainly reduces this otherwise formidable work to comparatively simple terms.

A Rotating Cutter for Tunnelling Through Soft Material

The paper describes a recent design for a cutting mole used by United States Corps of Engineers in driving outlet tunnels at the Oahe Dam project. The mole is made up of the following parts:—

Cutting head.
Shield.
Assembly jig for tunnelling sections.
Mucking conveyor belt.

The front part of the mole is supported on an adjustable steel shoe which slides along the excavated tunnel surface. The remainder of the weight is carried on flanged wheels which run on 13 ft. gauge rails. As work proceeds the 12 ft. rail sections are picked up, leap-frogged forward, and placed in position ahead by means of a built-in chain hoist. Forward propulsion of the mole is affected by hydraulic jacks bearing on tunnel ring sections previously positioned. Horizontal and vertical control is provided by additional jacks, assisted by a pilot bit and cone. The machine is powered by two 200 h.p. electric motors, and torque is reduced to a minimum by arranging the cutting head to rotate in two sections; an inner one which rotates in a clockwise direction, while the outer head rotates anti-clockwise.

A rate of working achieved with this equipment in shale was 3 ft. per per hour with a best rate of 5 ft. per hour. It was found that the teeth on the cutting edge needed replacement after 40 ft., an operation which took $2\frac{1}{2}$ hrs. to complete.

Drilling by the Reverse Circulation System

A system of drilling is described in this article which dispenses with a casing or mud to support the walls of the hole during drilling. In the reverse circulation system the formation is penetrated by a slowly rotating scraper or other type of drill attached to a column of large diameter drill pipe; water is allowed to flow very gently into the annular space between the drill pipe and the wall of the hole; and the cuttings are sucked up the drill pipe by a gravel suction pump, and it may be returned again after settlement.

An initial requirement is an adequate supply of water which must be applied to the bore with a head of not less than 6 ft. above the natural water table level. The velocity of the descending water is thus very slow, and by virtue of the outward movement from the hole to the sand the face of the cavity is prevented from collapsing; while the velocity of the water pumped up the drill pipe is high enough to carry all debris to the surface. There is by this means no washing and eroding effect on the wall of the hole from the velocity of the circulating fluid. A further advantage of this system of drilling is that samples are brought to the surface very quickly after cutting without contamination from other strata, and thus are valuable in determining soil types encountered.

Extracts from *Civil Engineering*, July, 1956

Construction Accidents

The leading article draws attention to the fact that for an 18 year old new entrant to the industry, there is a 3 per cent probability that he will be killed in a site accident before the age of 65, and that a further 2 per cent will be maimed. The blame for this serious state is divided between designers, management and workers. Designers are blamed for inadequate knowledge of constructional loads to be applied to false work or skeleton frames; the management for not enforcing strict safety precautions, especially where plant is concerned, and the workmen for circumventing safety regulations, especially in cases where these would appear to reduce production when on bonus rates.

Air-Conditioning System

A novel form of ice air-conditioning plant has been installed in a nickel mine in Ontario. Into a large stope (or tall chamber) especially excavated for the job, cold surface air (at $-25°$) during the winter is delivered by fan. Water from the mine workings is sprayed into the stope; this freezes and falls to the bottom of the stope where it gathers. It is estimated that up to 140,000 tons of ice will be formed during each winter. The latent heat given up by the ice warms the air, and this, together with the normal below ground temperature of the rock, raises the temperature of the fresh air inlet at the face to about $+32°$.

In summer, the hotter surface air is drawn through the stopes and over the accumulated winter ice which not only cools the air by about 5°–10° but also reduces its humidity.

It is claimed that this system saves the company 100,000 gallons of oil or 850 tons of coal a year.

Concrete Thinking

A plea is made by Mr. K. K. Kelvey for a reappraisal of our standard methods of design, and of the code of practice to enable more economical sections and joints to be designed. He points out that much precast concrete work in buildings is designed fundamentally as though it were made up of pin-jointed steel members. He suggests that much greater cognisance should be taken of the "stiffness" of concrete joints and that columns and beam connexions should be precast, as solid joints, possibly in the form of a Maltese Cross with cantilevered legs of about $\frac{1}{3}$ beam span. The author says that using this system he has built a twenty-two storey building entirely in precast units, and has shown a saving of about 15 per cent in steel and 14 per cent in concrete over traditional methods.

Dartford–Purfleet Tunnel

Of particular interest to many Sappers at Chatham is the description of the proposed new tunnel linking the A2 (London–Rochester) with the A126 (London–Tilbury) roads. The main tunnel will be circular and 28 ft. 2 in. diameter inside lining. The lining will be of flanged cast-iron segments bolted together and further caulked with metallic lead. The back of the lining will be injected with cement grout.

The tunnel will be driven entirely in water-bearing ground and therefore tunnelling operations will be carried out in compressed air. This work will be carried out behind shields and these latter are designed to be moved forward by peripherally mounted hydraulic jacks.

A pilot tunnel 12 ft. diameter was driven and lined before the war. The work now consists essentially of opening this out, using the pilot tunnel to treat and consolidate bad ground ahead of the workings.

The finished carriageway will be 21 ft. between kerbs and will carry two lanes of traffic. The minimum headroom will be 16 ft.

Review of Contractors Plant

Huber Warco Motor Graders

Two new motor graders featuring torque converters and full power shift transmission have been introduced into the country by Blackwood Hodge. The larger model is 140 h.p. and the smaller 100 h.p. All controls including side shifting of the mould board are performed hydraulically.

Free Piston Engine

Associated British Engineering Ltd., have introduced two types of free piston gas generators: the GS.34 of 1,000 shaft h.p., and the CS.75 of 350 shaft h.p. Installations so far completed have been for generating sets and marine and rail propulsion units.

A brief specification is:—

	GS.34	*CS.75*
Engine Cyl. bore (in.)	13·4	7·5
Compressor Cyl. bore (in.)	35·4	20.75
Over-all length (ft.)	13·75	7·5
Specific fuel consumption (lb./gas h.p. hr.)	0.320	0.325
Weight (tons)	8	2.25

Small Tracked Dumper

A Ransome I.T.C. industrial crawler tractor has been fitted with a $\frac{2}{3}$ yd. dumper box. The box is mounted forward of the driver's seat and is manually operated and self-tipping.

A brief specification is:—

Net Weight—16½ cwt.
Hopper capacity—15 cu. ft.
Load capacity—17 cwt.
Ground pressure loaded—4½ lb./sq. in.
Engine—600 cc./7 b.h.p.
Fuel consumption (average for 8-hr. day)—4 gallons.

CORRESPONDENCE

Oriel College,
Oxford.

19th September 1956.

The Editor, *R.E. Journal*
Dear Sir,

Field Engineering Tasks in Nuclear Warfare

In his Cooper's Hill War Memorial Prize Essay (published in the September, 1956, *R.E. Journal*) Captain Wright has discussed the desirability of further application of mobile machine power and indicated the form in which it should be provided, but he has limited his discussion of practicability mainly to peace-time expense, and has not mentioned what may well be the major factor in nuclear warfare, shortage of oil fuel.

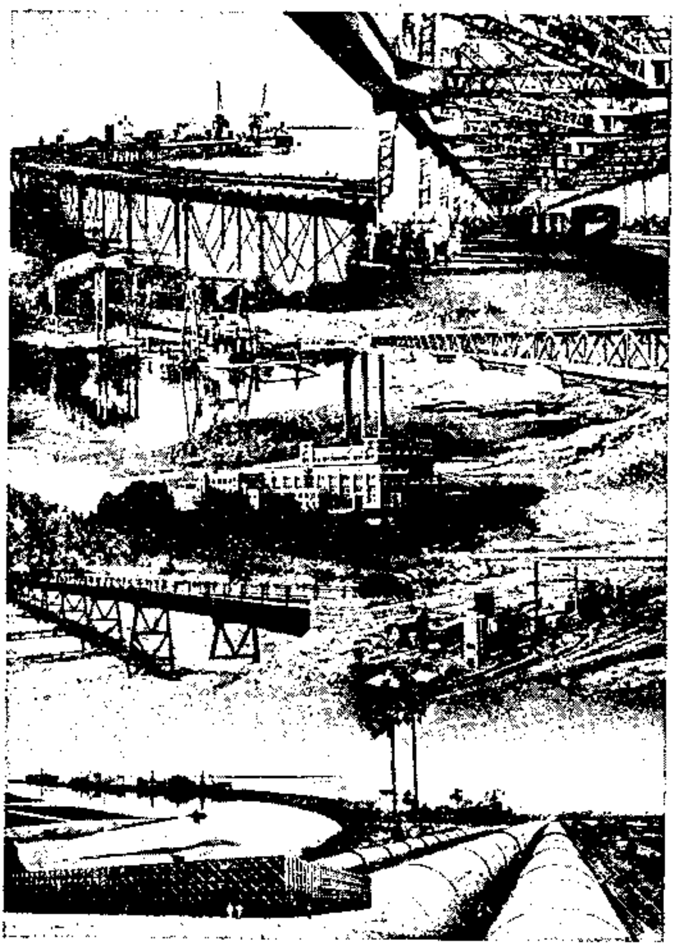
During the initial battle for air supremacy, it may well be that the enemy might choose as one of his major targets, the oil refineries and tankers on which not only our air and land forces depend, but also the life of this country. Even minor peace-time crises such as Abadan and the Suez Canal cause considerable perturbation about the security of our oil supplies; it would not take many atom bombs to cause a breakdown. There would of course be severe rationing and part of the problem would be self adjusting as the population depending on oil would be reduced by nuclear casualties, but within the fighting services there would have to be the strictest priorities, and the air forces would head the list.

If this forecast should prove to be correct, the land battle would be won by those forces that could achieve some mobility and hitting power before the others. Under such conditions the tasks for field engineers would demand improvisation, luckily traditional in our Corps, and the ability to impress and organize any local labour that could be found to carry out tasks with the minimum use of oil fuel. Even in forward areas, local supplies of fuel such as coal or timber would have to be organized, and power stations patched up; trains might be made to work on coal, wood, or in favourable cases electricity; anything to conserve oil fuel for the air forces and the smallest minimum of armoured mobility. Manpower must be fed, but it can and must also work, and work with primitive tools instead of sitting down and weeping because there is no oil for the labour-saving machines. And for the future, for we must look ahead, mobile machines working off electric batteries, charged by mobile atomic power plants. Fantastic, perhaps, but not so fantastic as the idea of an army hitting hard and going like hell with half the world's oil refineries in ruins and most of the tankers sunk.

Yours faithfully,

R. E. BAGNALL-WILD, Brigadier (retd.)

Editor's note. This letter was received before the latest Suez Canal developments.



Careers in Electricity

This is an extract from a recorded interview with E. O. Maxwell, an established C.E.A. engineer, aged 26

"... in Power Stations I could get variety and responsibility"

Q.M.: **What first made you come into the Industry?**

Mr. Maxwell: I saw an advertisement for graduate training and it struck me that in power stations I could get the type of experience I wanted—variety and responsibility.

Q.M.: **Any particular reason why you chose this part of the world?**

Mr. Maxwell: Only that my people were living in the South of England so I voted to do my training here.

Q.M.: **After your training . . . ?**

Mr. Maxwell: I was appointed Assistant Engineer—plant testing—Croydon B. My first ambition, of course, was to be in charge of a shift.

Q.M.: **Which you were. Weren't you a Charge Engineer before you were 23?**

Mr. Maxwell: Yes. Assistant two years and two months, then Charge Engineer. I was very keen on being responsible for staff and it suited me fine.

Q.M.: **What are your plans now?**

Mr. Maxwell: Well, my plan at the moment is to gain as much experience of the design and construction — construction side mainly — of nuclear power stations. Actually I shall be going, for two years, to one of the Atomic groups in about four weeks' time. My ultimate aim is really to get back into power stations.

Q.M.: **You don't see yourself spending all your time in a nuclear power station?**

Mr. Maxwell: Oh, no. I'm much too young at the moment to specialise. I want to get as much general experience as I can.

We'd like to publish more of this interview, but there isn't space. For details of the many careers in Electricity open to you, and the salaried training schemes available, please write to:

**The Education and Training Officer,
Central Electricity Authority,
10 Winsley Street,
London, W.1.**