THE ROYAL ENGINEERS JOURNAL

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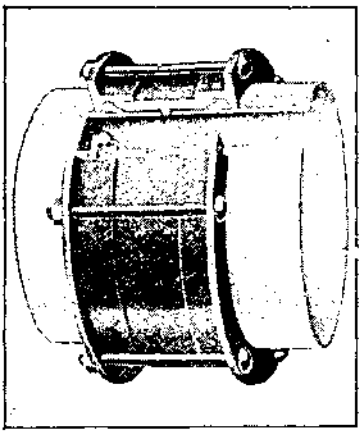

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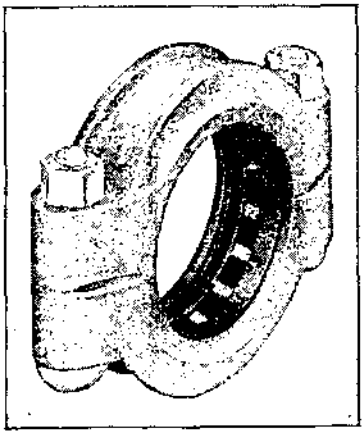

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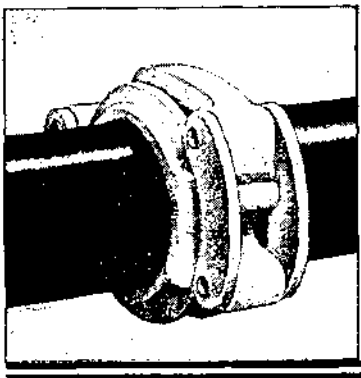

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The Royal Engineer Party at the British Columbia Centenary

By Captain G. R. Gathercole, R.E.

Introduction

"These territories are bounded by frost and backed by fog, and woe betide any unfortunate individual who might be so diverted from the paths of prudence to settle in these parts."

Chancellor of the Exchequer, 1842.

This article describes the visit of a party of Royal Engineers to the territories referred to, now the Province of British Columbia in the Dominion of Canada. This party consisting of an officer (myself), a warrant officer, and four other ranks went to take part in the Centenary celebrations held in the summer of 1958 to commemorate the part played by the Corps in the development of British Columbia. Little attempt has been made to give the history of the part played as this was covered in a previous article in the *Journal* of June, 1958, by Major D. Veitch, R.C.E.

The Preparation and Outward Journey

Last February, having left my regiment to sail home from Christmas Island in the *Dunera*, I flew to the United Kingdom in a Comet. The Corps party was to be of all ranks, representative of all branches, and they had to fit the small selection of 1858 uniforms which Mr. Thornton, the then Curator of the Corps Museum, had in the meantime obtained. All units within the United Kingdom were asked to recommend regular volunteers in various ranks to fit these uniforms. The initial selection of the large number of those wishing and recommended to go who came to Brompton Barracks in early March provided all the thrills of a pantomime scene. The tailor's shop was full of a succession of hopeful "ugly sisters trying on the glass slippers", with a watchful curator to see that the precious red tunics were not coaxed on too firmly. From this and by interview and record we soon had a party of the right rank structure, and size, with reserves.

In Canada we had to be prepared to enact the part of Sappers of 1858, and to do a guard-changing ceremony. In mid March the party assembled at Kitchener Barracks to learn the old-fashioned drills, the detailed actions of the original party, and to generally prepare themselves for the visit. From the R.E. Library, and the War Office Library, we obtained two drill manuals of 1848 and 1862 and from passages like this soon mastered the likely drill movements which we would have to perform.

Standing at Ease. "On the words Stand at Ease, the right foot is to be drawn back about six inches and the greatest part of the weight of the body brought upon it; the left knee a little bent; the palms being struck smartly together, and that of the right hand then slipped over the back of the left; but the shoulders to be kept back and square; the head to the front, and the whole attitude without constraint."

There was great difficulty in finding the type of rifle which the 1858 party had been issued with. This was a Lancaster, a nicely balanced oval-bored

muzzle-loader, which had only been issued for such small expeditions before being superseded by rifles with the Schnieder breech-loading action. The Armouries of the Tower could not help us on such a trip where we were actually going to use them. Six of these we were loaned eventually by the Royal Artillery Museum in the Rotunda at Woolwich, and we completed them with bayonets and scabbards from the Museum of the Small Arms Section at Enfield. The Inspectorate of Armaments at Woolwich put the party through a short course of how to make up the proper charges with black powder, and tested them all to ensure that they were still quite safe to use. Despite their age all the rifles cleaned up like new, and stood the test of actual use for they all were to have over 100 rounds of blank fired through them without suffering any harm.

The R.A.O.C. proved most helpful by finding exactly the right kind of gloves and equipment, and even produced brand new Royal Engineer busbies. Thus when we had our first full dress parade on the square at Brompton many surprised Sappers saw a party dressed as closely as was possible to the style of 100 years ago.

On 23rd April we flew from London Airport to Montreal by Trans Canada Airlines, having sent our uniforms by sea and rail to Vancouver. After a stay overnight at the R.C.A.F. base at Lachine we continued in a very noisy transport plane via Winnipeg to Edmonton. As we left Edmonton next morning there were 3 in. of snow on the ground and a light blizzard blowing, but after we had been in the air for thirty minutes we broke into a clear sky. Below us the sight was breath-taking, as far as the eye could see were the desolate snow-capped peaks of the Rocky Mountains. For this stage of the journey we were travelling in the C119, the R.C.A.F. equivalent of our Beverley, at 12,000 ft., and even then some of the mountains seemed to pass quite close below.

The six-hour journey passed quickly as we watched the scenery, soon only isolated peaks had snow on them, and the country had become brown desert; lakes deep blue in the sunlight, and patches of green around isolated small towns where the crops were artificially watered. Not that we could go to sleep for the steward kept us awake, lest we slept too long for lack of oxygen. Soon the mountains opened out to show a large green fertile plain with sea on the far horizon, the Pacific Ocean.

We landed at Sea Island Airport, Vancouver, in mid-summer conditions so different from the wintry prairies that we had left behind. The air was warm and scented, fresh green leaves on the trees, and flowers in full bloom.

Some of the party looked a little green as they emerged from the aircraft, as it had made an abrupt stop by reversing the pitch of its propellors, this for them was nearly the climax of a rather bumpy trip. We were met by Captain Derek Woodhead, Q.M.S.I. Jasper, and Q.M.S.I. Day, all Royal Engineers, who were to help us so much during our stay at the Royal Canadian School of Military Engineering at Chilliwack, some sixty miles east of Vancouver.

Chilliwack

The Royal Canadian Engineers have reason to be proud of Camp Chilliwack with its landscaped grounds, large administrative buildings and its modern barrack blocks, all set against a background of mountains. The Royal Canadian School of Military Engineering here was to be our base during our stay in British Columbia.

Two Canadian Sappers joined the "old guard" as we found we were to be called. Both were of recent British extraction, and we soon had them looking like us by dressing them in the uniforms made for them in England, and getting special permission from the R.S.M. to let them grow their hair to a reasonable length.

The "new guard" of Royal Canadian Engineers of similar size and composition commanded by Captain B. Brevic, R.C.E., joined us. They were dressed in Tropical Worsted uniform with a peaked hat, and armed with F.N. rifles. To complete the show we had the band of the 1st Field Engineer Regiment. Together, with much reference to *Drill—All Arms 1951* and *Manual of Drill—1848* we worked out and rehearsed a symbolic Changing of the Guard Ceremony lasting forty minutes which could be performed on the many various locations which we were to perform in, baseball diamonds, streets, athletic grounds and even once on a drill square.

We were backed up by a forceful publicity programme and what crowd the band could not draw, the old guard could by discharging its firelocks in a *feu de joie!*

Our first performance at the International Trade Fair on 1st May gave us a glimpse of what was to follow. Centennial Year Celebrations in British Columbia were really getting into their swing. We were but one of the many attractions imported specially for the Centenary; ski-jumpers of international fame jumping on a specially made tower, famous musicians, the entire Royal Marine Band flown in specially for a tattoo to rival that at the Edinburgh Festival were but a few of the things on which the Government of British Columbia was spending its $7 million Centennial Fund. It expected to get it all back many times in the many forms of trade that it would bring.

Shortly after this to get our pictures in the paper we went along to see an old lady of 102, a Mrs. Ross, the wife of a Sapper in the original party. She was a little taken aback at first at seeing three highly colourful men, with whiskers, but she quickly smiled and said "Gee, you Sappers always were a fine looking bunch of rogues!"

After being present at the laying up of the colours of 7th Field Engineer Regiment R.C.E. (Militia) at St. Mary's Church, in Sapperton, recently pictured in the Corps Christmas card, our next engagement was at the Annual May Day Celebration of the City of New Westminster. This always takes place on a day in early May, and the signal that this day is really a holiday for all the school children is a big explosion in Stanley Park. This was started by Lieut.-Colonel Moody, and is still traditionally carried out by the local Royal Canadian Engineers. It is followed by a procession of many floats, beauty queens, High School Bands, and of course the May Queen and entourage; to a huge arena in Queen's Park where a varied display by many hundreds of school children and adults lasting several hours takes place.

To see 800 children gaily twirling their ribbons round eighty Maypoles is indeed a colourful sight. May Day in New Westminster is famous throughout North America, and many hundreds of people, with their own May Queens and floats came from neighbouring states of the U.S.A. to see and take part.

Prince George and the Frazer Brigade

At the end of May we did our first long trip up the Frazer Canyon, this our farthest north, was to Prince George, some 400 miles north of Vancouver.

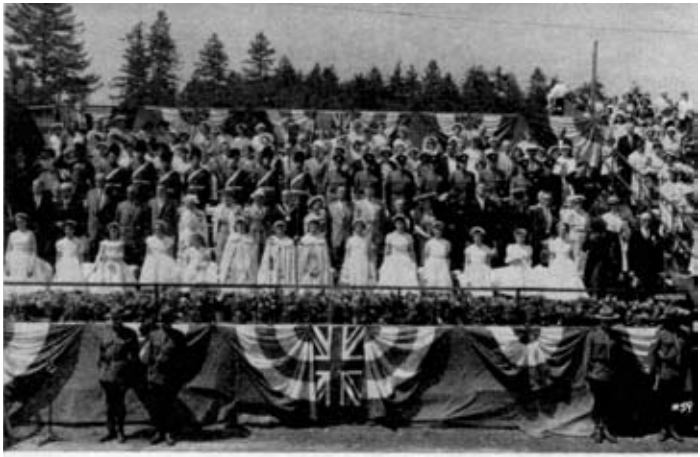


Photo 1.—Old and new Guard at the May Day Ceremony in New Westminster.

Photo 2.—The Alexandra Suspension Bridge over the River Frazer, its abutments are in the same position as those surveyed for the original bridge by Sergeant McColl, R.E., in 1861. In 1894 the waters rose to within 10 ft. of the deck. The C.P.R. line, the C.N.R. line, and the new highway can be seen above the river.

The Royal Engineer Party 1,2

The Pacific Great Eastern Railway was only carried through to Prince George as recently as 1956. It has most modern stainless steel railway coaches, which seem obligatory throughout North America, all in communication from station to station by VHF radio. The territory through which this single line passes embraces farming, lumbering, mining, manufacturing and an abundance of water power all of which will be required as British Columbia continues to grow. Prince George has the reputation of being a boom-town, and it seems to live up to it, for it has the go-ahead atmosphere which must have marked the frontier town of a century ago. The recent extension of the railway to it makes it the centre of the development for the Peace River Country, and the Rocky Mountain Trench generally, of which the recent survey shows to have vast mineral wealth.

This journey was to be the start of our association with the Frazer Brigade. This was a crew of men who knew the river well re-enacting in detail the journey of Simon Frazer down through the Frazer Canyon in 1808. Frazer, Quesnell, five Canadians, and one Indian, all dressed for the part following Frazer's diary exactly, doing everything on the same days he and his men did, in three 20-ft. long birch bark canoes. Some stretches of the river are impassable for a canoe, and for these the only concession given was a 40-ft. fast motor launch to avoid the "portage" along the rocky bank.

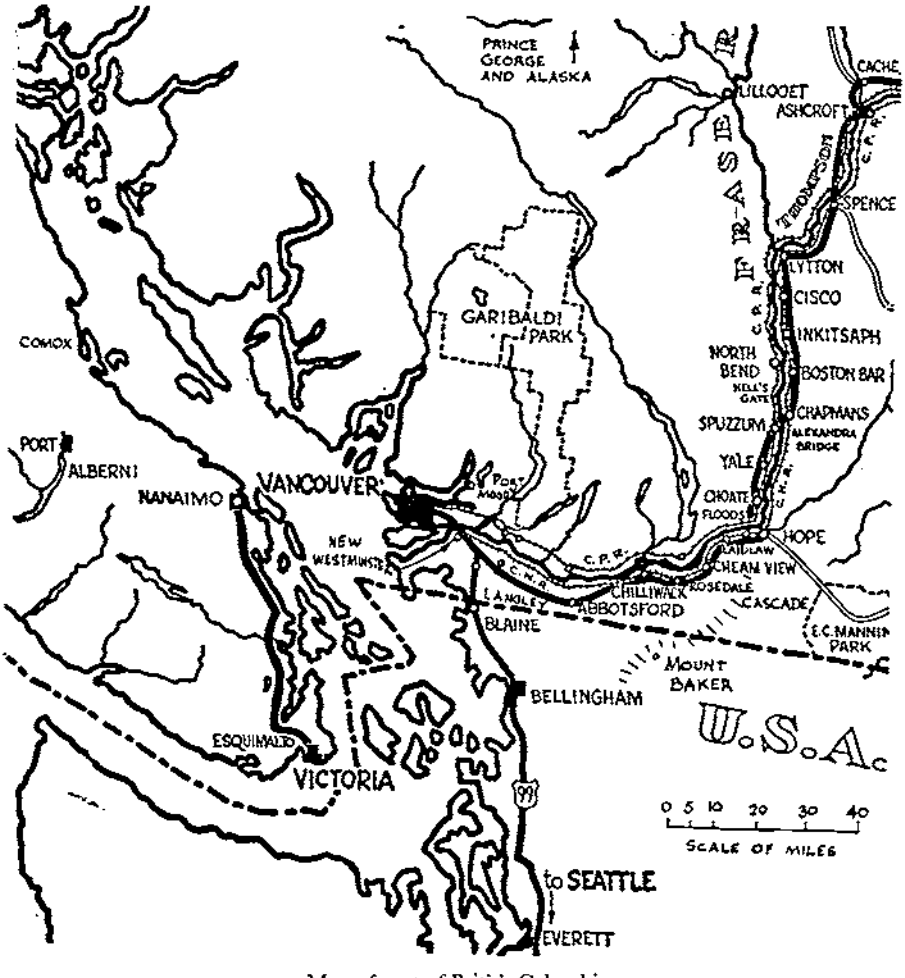
Over the next two months we were to do our show with them as part of the evening events for the towns at which they stopped.

Also to meet them there were a small group of actors and singers who told the essentials in costume of the story of the River Frazer. Each show was different as the cast was supplemented by acts, and little celebrations, staged by the people of the communities themselves. Centennial dress and beard growing contests were the fashion throughout the province so it needed little effect for a town to provide the necessary local colour to these pageants in the form of bearded miners or shapely "hurdy gurdy" girls.

Once sheltered from the sea by the coastal range the country turns to desert, cactus and tumbleweed; this is cattle country called the Cariboo. The biggest ranch in the world is in British Columbia. Travelling for us was not without its dangers. As we drew out of a modern cow town, Williams Lake, we were shot at. S.S.M. Foster looking out of his train window was surprised to see a man pointing a rifle at him, and was even more surprised when the window shattered above his head. The train stopped, and a message was sent on the radio back to the station. Up came the Mounties to investigate, and somebody wisecracked that the band hadn't even played. We subsequently heard that the mounties got their man, and that he got ten months inside for stealing a car and being too quick on the trigger.

The Road to the Cariboo

The River Frazer draws its waters from an area of over 91,000 sq. miles. Its muddy waters mingle with the blue of the River Thompson at Lytton and together they have cut a terrible chasm through the mountains on their way to the sea. In 1861 this canyon and the mountains lying to either side were carefully surveyed for a route and in the following year Captain Grant, of the Corps, started construction. His party in general built the more difficult parts, and the civilian contractors made the easier sections. Despite their working only with hand-tools, and explosive, 6 miles of road 18 ft. wide were quarried out of the rock walls during the first year of construction.



Map of part of British Columbia.

This road is now part of the Trans-Canada Highway and on it one can now travel up to the general British Columbia speed limit of 55 m.p.h. The party was to get to know this route very well by night and day, for nearly all the towns at which we performed lay on it. Even today the road is a frightening one, and many tourists have stopped, sweating slightly, and decided that they will do their motor tour in some other part of British Columbia, after experiencing a few of the bends, and seeing the edges of 1,000 ft. almost sheer slopes so close to their front wheels. The entire old and new guards and the band travelled in a station wagon and a bus, and it was probably as well that we usually returned to Chilliwack in the darkness of the early hours.

We found a small portion of the original route intact, near the Alexandra Suspension Bridge (see Photo 2). It remains as a rocky tree-aisled route in most places covered by moss hugging the steep sides of the slope down to the swirling river several hundred feet below. In most places it has been replaced by the more modern road, or the Canadian Pacific Railway which later used it as the only way along the river.

Another portion clinging to the cliffs supported only by flimsy trestles was near Hell's Gate. Here the full torrent of the river passes through a gap 100 ft. wide at the speed of 25 ft. per second. Although travelling at this speed the river is 100 ft. deep at this point and rises yet higher with the melting of the snows in late spring.

The Frazer River and its tributeries are a home to more spawning salmon than any other waterway in the world. This, and the closeness of the highway and the two railways, the C.P.R. and the C.N.R., which follow it, preclude the building of dams to harness a half-million horsepower of energy estimated in the flow of its waters through the canyon.

The rich rewards to be gained in the Cariboo gold fields attracted many novel ideas on how to get the best from this winding, precipitous road. One idea, probably caused by the barren desert-like country covered only by jackpine and sage brush above Lytton, was to import twenty-one camels from Africa. These were able to carry 1,000 lb., compared to the mules' 200 lb. Freighting was made easier for a few journeys, but then the camels' feet proved too soft for the rocky ground, and their strong scent threw other animals into panic, causing several falls. So they were sent away to the coast and Thompson River areas where the last died in 1905. One can but think that many miners must have taken the pledge after seeing a fully-loaded camel plodding through the snow towards them.

Many miners made fortunes, but expenses were high. The stage coach fare from Yale to the gold fields was $130, the fare by Greyhound Bus is now just over $13. A Mr. Barnard, later a prosperous man, was probably the most energetic postman in the world, for he carried a pack over the 380-mile jaunt, each way, on foot. No wonder that he charged $2 per letter, and sold newspapers at $1 apiece.

The party did not have any time to go and look for gold but it is still there. It is possible to make a steady $5 a day panning gold on the River Frazer, but unemployment benefits are generous in British Columbia. There are a few officers at the Royal Canadian S.M.E. who still find it worth while to leave the cares of family and job behind, take a few days' leave, and in the solitude of the bush wash out grains of gold from the sands of the river.

Panning for gold, is, in my opinion, even more absorbing than "pot holing." One buys a pan, rather like a frying pan without a handle, and takes it to an accessible spot along the river's edge where the water has been slowed by a sand bank or a boulder. One scoops up a panful of gravel, and just rocks it under the surface of the water to remove the lighter mud and organic matter. Now one takes out the bigger pebbles, and repeats several times until only a small quantity of black "pay dirt" is left. Now comes the interesting part, by swilling a small quantity of water over this one can spread this out for examination. If one has picked the right spot and has worked carefully one is rewarded with a few "butter yellows" in the pan. These can be lifted out with the end of a dampened match stick, and shaken off into a small bottle. If there are not any, well, one knows that the heavier gold would have settled down a bit. Dig deeper! Try behind that boulder! It is common knowledge that there is always richer ground close by! Soon the hands of the watch have spun round, thoughts of food and worldly affairs are forgotten. One has caught "gold fever" and for a considerable distance the bank is covered with scratchings and ditches.

Victoria and Vancouver Island

Eight days in early July we spent giving eight performances on Vancouver Island. For some of this time we stayed at the Royal Canadian Navy base at Esquimalt, which still has many buildings built by the Corps in use.

Victoria, the capital of British Columbia, is very English in character, and because of this, and the beauty of the island, draws many thousands of American tourists, to purchase British chinaware, woollens, and even antiques on sale there. We did the guard-changing ceremony in our most impressive setting of the whole tour here on the green lawns in front of the Parliament Building to a crowd of 3,000 despite the rival attraction of the Royal Marine Band in the park.

The old guard also faced the television cameras here for the second time, being interviewed and doing some old drill movements. Our first appearance on C.B.C. TV in Vancouver, the producer was most worried about "discharging firearms in a public thoroughfare," but let us do so before the cameras. The resounding bang apparently convinced many people that their sets had blown up!

Our stay with the R.C.A.F. at Comox farther up the island coincided with the run of Cohoe salmon. The party had all been fairly successful at trout fishing in the lakes near Chilliwack, but had no success at deep trolling after the bigger fish.

The pattern of our days on the island followed that of the remainder of the tour. Saturdays and Sundays were our busiest days when we usually had some ceremony to perform at. During the weekdays our performances took place in the evenings, so we fell into "show business" timings, and our schedule went like this:

1600 hrs. Leave base for the place at which we were to perform
1830 hrs. Arrive and have a meal
1900 hrs. Change into our uniforms
1930 hrs. Guard-changing ceremony
2200 hrs. Saluting the flag ceremony at the end of the Frazer Brigade Show
2300 hrs. Usually the town had a dance which we attended in 1858 uniform
2400 hrs. Move off back to base
0200 hrs. Supper and so to bed
1100 hrs. Parade to clean kit or rehearse a new routine
1600 hrs. Move off.

This continued for three lots of eight consecutive days, and became quite tiring!

The River Frazer

When the River Frazer bursts from the canyon at Yale it slows to wend its way through a verdant land of marshland and meadow; dairy country and hop fields; log booms and lumber mills until it comes to one of the world's best natural ports: Vancouver.

During our stay at Chilliwack we visited various towns on the Frazer Delta, all making some contribution to the Centenary.

Vancouver, a typical North American city, all colour, advertising, hustle and bustle, has the most wonderful natural setting. We did not try, but one can swim in the bay, and ski on Grouse Mountains in the same afternoon.

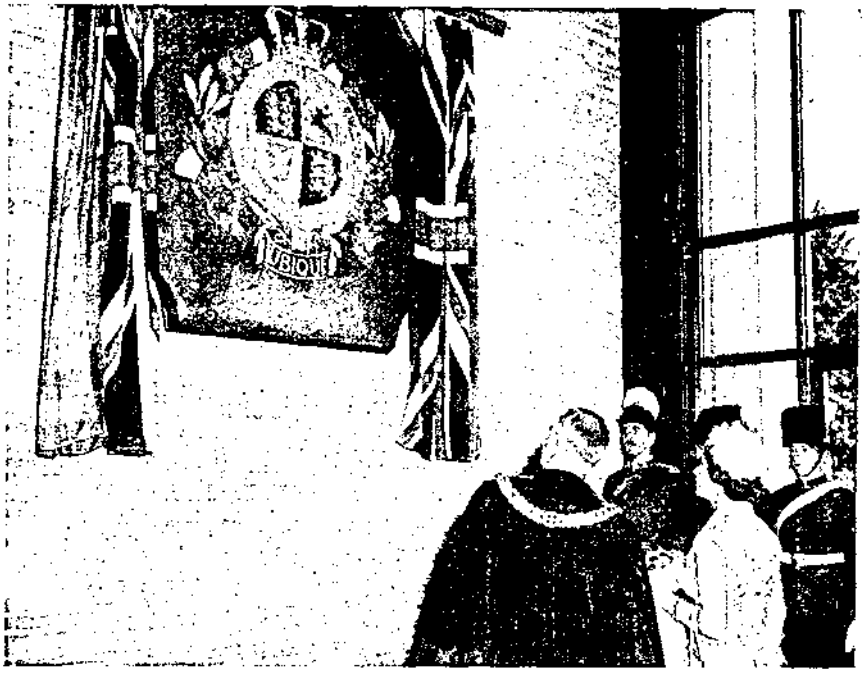


Photo 3.—H.R.H. Princess Margaret inspecting the plaque, showing the Arms of the Corps in 1858, in the City Hall at New Westminster.

Here we had the climax of our tour, as part of a huge show called the "Sea Spectacular" for 30,000 people sitting on the shores of Kitsilano Bay. This show took place on a barge anchored off shore, all the cast having been taken for a tour of the harbour in a lumber millionaire's yacht, which was later moored to it and used for dressing-rooms.

Our hosts in Vancouver were 7th Field Engineer Regiment, R.C.E. (Militia), commanded by Lieut.-Colonel Shore, who looked after us very well. 6th Field Squadron in North Vancouver has helped many a Sapper stranded in Vancouver on his way to Christmas Island. They have been in the same spot for nearly fifty years, and there is a most colourful poster in the R.C.E. Museum in Chilliwack recruiting Sappers to their Armouries for the First World War.

In late July the guard performed every evening for a week at Fort Langley, a reconstruction by the provincial government of the Hudson Bay Company of the fort in which the Crown Colony of British Columbia was inaugurated on 19th November, 1858. Only one of the original buildings remains but others have been built exactly as they were with hand-hewn timber. This remaining building now houses a museum, which has among its exhibits various old R.E. tools, and an old account book which shows that a gallon of whisky cost $5 and was paid for in gold dust.

The first of this series of performances at Fort Longley was at its opening as a Dominion Historic Site by H.R.H. Princess Margaret, on 22nd July. This was televised throughout Canada, and a radio commentary broadcast on the B.B.C.

The Royal Engineer Party 3

Photo 4.—H.R.H. Princess Margaret talking to Sergeant Tucker, R.E., others in the picture are Sapper Thomas, L/Corporal King, Corporal Miller, W.O.II Foster, and W.O.II Day, Q.M.S.I. at the Royal Canadian S.M.E., Chilliwack.

The next day the old guard, together with the R.E. attached to the Royal Canadian S.M.E. at Chilliwack, were present at the unveiling of the plaque presented by the Corps to the City of New Westminster by H.R.H. Princess Margaret. The Princess spoke to us each individually, and finished up by saying with a twinkle in her eye "I expect you have all had a great time."

The Return

On 1st August came the time for us to say farewell to Colonel Carson, and all at the Royal Canadian S.M.E. who had looked after us so well during our stay. B.C. had had fifty-five consecutive days without rain when we left and many thousands of dollars worth of timber was burning in forest fires. Once our bus was stopped by one which was nearly under control; had it not been, we would have had to have helped, for the R.C.M.P. have immediate power to conscript men off the streets in a town to help in fighting a forest fire.

The Royal Engineer Party 4

Our stay had been a busy one, but we had, helped by the R.C. S.M.E., managed to get two three-day trips into the U.S.A. The first was to Mount Baker, where two of us were able to have an afternoon's ski-ing at 16,000 ft. in mid-June, and then on to fish, staying at a log cabin on a nearby lake.

Our second was a small shopping trip to Seattle, prices in the U.S.A. being somewhat lower than Canada, and we were shown the town by arrangement with the U.S. Armed Services Police.

The band which had travelled so far with us played us off at Vancouver Airport with "The Sapper's Lament", a march which they had composed during the tour. For them it was a lament, for they had to face their disbanding with the 1st Field Engineer Regiment and a return to less colourful soldiering. During our two days in Montreal we went to parties given by 3rd Field Engineer Regt. R.C.E. (Militia), and the local R.C.E. Works Company, and they saw us off on the *Empress of Britain* on 5th August. Rest and recuperation on the six-day crossing were really necessary.

During our stay in British Columbia we had travelled over 5,000 miles by road, and performed fifty-eight times. We all considered it part of the job to talk to people about "the old country" and got great pleasure from doing so. We met all kinds of people and found them to be friendly, with a way of life just like our own; working hard and playing hard. My own impression is that there is a little too much emphasis on material things, but the compensation is that a man gets his rewards earlier in life. There is also, perhaps, too much emphasis on individual personalities.

The party was very fortunate in going out to commemorate the part played by the Corps in the development of the Province into the vigorous land it has become. Anyone would be proud to play a part in its future.

The Effects of Atomic Warfare on Engineer Operations

By Major A. E. Younger, D.S.O., R.E.

The statements and opinions expressed are of the Author alone.

Editor's Note. This article was written in May, 1958, but due to lack of space was not published earlier.

Introduction

The object of this article is to assess the implications of atomic war on field engineering. It does not consider the problem of the Army or Communication Zone engineer.

It is divided into three parts, covering first the engineer in withdrawal and defence, second in advance and attack and, lastly, the effects of atomic war on the individual sapper which overlap both the other parts.

In the first two parts only the main subjects of demolitions and of crossing water obstacles have been taken. There are many other subjects which could and should have been included but it has been thought better to restrict them to the most vital.

It will be seen that the last part is rather different to the other two in that it goes into more detail. Although these details will already be known and appreciated by many, they have still been included since their importance is such that they should be disseminated in the widest possible way to officers.

Engineers in Withdrawal and Defence—Demolitions

Conventional demolitions are not greatly affected by atomic warfare. It seems that there is no marked tendency for sympathetic detonation to occur, perhaps because the impact of the blast wave from an atomic explosion is comparatively gradual at distances of several hundreds of yards from GZ where sympathetic detonation might be expected. There is a danger that explosives and leads attached to bridges will be removed by the very high winds generated by an atomic explosion. But this is unlikely to happen as the risk only occurs in a narrow zone that lies on the fringes of the relatively large circular area round GZ where bridges would, in any case, be destroyed.

The potentially revolutionary change to engineer demolition techniques lies in the possibility of hand placing atomic warheads. Any nation possessing nuclear weapons that can be fired from a gun or dropped from a plane obviously has the capability of exploding the same warhead statically. This gives the engineer control of power that is immensely greater than anything he has had in the past.

Two possibilities are opened up. First, the use of the blast and heat effects of nuclear fission for straightforward destruction and, second, the use of radiation to contaminate and deny ground, rather in the same way as a huge chemical mine might be employed.

Destructive Effect

Taking this first, the mind jumps to the chance of attacking vast engineering works such as dams, canals, big bridges, airfields or even whole ports.

The advantages of the weapon are obvious. However, the circumstances surrounding its possible use need careful consideration as there are several disadvantages. The first disadvantage lies in the very power of the weapon. The British Army has seldom employed a scorched earth policy and the likelihood of it being required to do so in an atomic war, which is almost certain to be short, is small. This rules out the need to use atomic explosives on some targets. For instance, conventional explosives can destroy quickly the sluice gates of a dam, vital parts of a large power station or, in a canal, sink ships or break lock gates. This would be enough to put such targets out of action for a few weeks and no advantage would accrue from smashing them permanently.

The use of atomic weapons in heavily populated areas presents a limitation. Even in the unlikely event of adequate time for evacuation, the voluntary destruction of cities in our own or an ally's country becomes more of a political than a military decision. For instance, can the Danes be expected to destroy Copenhagen, or the Germans Hamburg, particularly as the warning period afforded to those towns is hardly likely to be long? The destruction of port facilities usually suffers from this disadvantage.

The case of large bridges raises the problem of the supply and delivery of the weapons. Atomic warheads must be brought from some secure store, probably many miles away, and by secure means. The time taken between the initiation of a request for a warhead and its installation on a target will be

measured in hours. Added to this, the need to warn other troops over a wide area and the difficulties of making remote firing arrangements indicate that rapid demolition devices with conventional explosives would be much safer. It is, in any case, wasteful to use the equivalent of, say, 5,000 tons of explosives when 5 tons would suffice, although this is no objection if warheads with a very much lower yield are produced.

The same limitations apply also to the destruction of airfields, but to a lesser extent. Delivery by air would be quicker and simpler, and an airfield takes a great deal of work and explosive to destroy by conventional means. However, an airfield is not normally destroyed unless there is imminent danger of it falling into enemy hands, so the time factor would still be critical.

The targets that seem to offer prospects are those for which great effort would be required if only conventional explosives were used. For instance, targets that would require a long mine shaft, such as a tunnel or a mountain pass, could be more speedily dealt with by atomic means if they happened to be of sufficient strategic or tactical importance to warrant it, and if the tremendous fallout were acceptable.

However, it is the fallout that presents the greatest disadvantage, since no surface or sub-surface atomic explosion can be "clean". If the wind happened to be in the wrong direction at the time of burst, it is not inconceivable that the discomfiture suffered by our own troops might exceed that which they would have suffered if the target had fallen into enemy hands intact.

The Denial Effect

It would be possible to contaminate a belt of ground by the use of a chain of atomic land mines. Again, great danger would arise if the wind happened to be in the wrong direction and the fallout came down on our own troops.

As we know, contamination decays quite rapidly, so it is unlikely that a commander would find the advantages of denying ground with it great enough to outweigh the unpredictable dangers of a weapon that is dependent upon the weather.

However, the greatest disadvantage of using radioactive contamination as a tactical weapon, lies in the delayed onset of symptoms. This type of threat will not stop resolute troops, nor ignorant troops with a ruthless commander.

A mountain pass might be denied to an enemy by the explosion of one or more atomic weapons to block the pass and contaminate it. The combination of circumstances that would have to pertain to make the effort worthwhile are that the pass should be in a remote area, so that the fallout would be no problem; that we should not require to use the pass ourselves for later operations and that the destruction and contamination could not be easily by-passed.

Deduction

The atomic warhead has such disadvantages to its use as a demolition charge or for denying ground that, unless a very small one can be produced or unless targets occur in very remote areas, it seems that conventional explosives could be employed with greater speed and more certainty.

Nevertheless, it behoves all Sapper officers to consider the possible use of atomic demolition charges under every strategic and tactical situation and to search for valid uses for them. As a Corps we cannot afford to discard such a powerful weapon without the fullest investigation.

Engineers in Advance and Attack—Water Obstacles

Due to the increasing rate of soil erosion all over the world and also the need for navigable waterways, most really big rivers now flow between artificial banks. Water levels are above the ground level of riparian plains during rainy seasons, and in some cases during all seasons. There is often a complex of subsidiary banks or dykes across the flood plain and usually large or small water catchment areas to control flooding.

The tactical exchange of nuclear missiles leading up to a river crossing operation is likely to disrupt these control measures completely. This means that an advancing army must expect to have to cross not only the main river but also an inundated area on one or both sides of it.

Fighting in such an area has been rare in the past and raises difficult problems. Experience in 1945, when the Rhine flood plain was inundated, showed that only tracked amphibians of the Buffalo type with experienced crews could be reasonably sure of effecting a crossing. DUKWS "bellied" themselves on hidden shallow spots and did not have the tractive power to pull each other off.

As roads in these areas are often built on dykes, it is usually possible to reconnoitre a route that can be used by tanks if the latter can wade through about four feet. Map reading or marking such a route is most difficult, unless, as sometimes happens, avenues of trees have been planted.

These are the conditions that armies may be faced with in nuclear war. The need for amphibians and helicopters is paramount. If these are not available the result will be that attacks (or counter attacks) can not be supported over long stretches of a river line. This will seriously impede flexibility and be a great curb to the mobility of an army.

A similar situation, but perhaps more dangerous to an army, arises if a large river crosses the lines of communication. It might not be possible to counter interdiction of the bridges merely by rafting and bridging, but extensive extra arrangements might also be required to enable vehicles to reach the original river banks.

The picture that emerges of supply over a major river in an atomic war is of a series of off-loading points on both sides of a flood plain. From these points supplies, reinforcements, casualties and equipment can only cross to the other side:—

(*a*) In helicopters or other aircraft.
(*b*) In amphibians.
(*c*) In tanks or properly waterproofed "B" vehicles.
(*d*) By pipelines or overhead ropeways if time allows.

In case (*c*) the tank or vehicle will be required to traverse, at very low speed, long stretches of inundated road to a ferry site. Such routes may easily be blocked, particularly, but not necessarily, by enemy action.

The likelihood of flood plains being inundated *accidentally* can be checked by studying large scale maps. Since it was possible to disrupt the great sea dykes of Walcheren with conventional bombs, *deliberate* inundation will not be difficult in atomic war. This still further increases the chance that flooding will be encountered.

Similarly, the interdiction of bridges will present little difficulty. If the enemy should attempt this, he will not allow us to maintain military bridges in the place of destroyed permanent bridges. The only hope will be in numerous ferries.

Another aspect of bridging that needs consideration is design. Are rigid pontoons the best to withstand atomic blasts in their vicinity, or are designs such as the American rubber type better? Can decking be designed so that there is less chance of the whole being lifted up by blast and twisted about? In a floating bridge, does a panel type of structure offer resistance to blast and therefore tend to be destroyed at a greater radius than other designs, such as those based on strengthened decking?

Effects on the Individual

The nature of their work makes engineers, of all arms of the service, the most susceptible to the dangers of radioactive fallout.

The size of these dangers is formidable. The amount of earth displaced by a surface burst weapon runs into hundreds of thousands of tons. The areas covered by the resulting fallout are large enough to make it not unlikely that a whole theatre of operations will be affected to a greater or lesser degree, if both sides make much use of nuclear warfare.

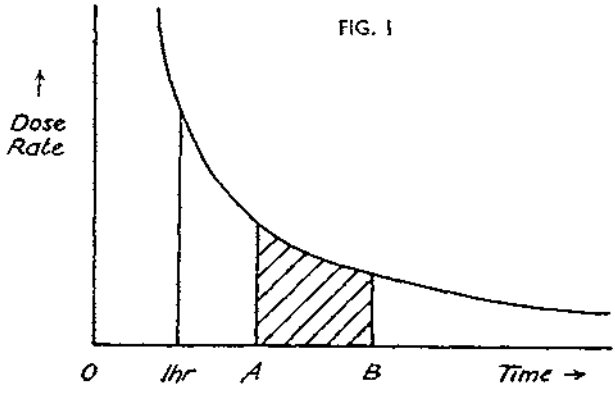
Dose Rates

Any officer in a field unit is likely to be faced with the problem of being ordered to do a job in the open in the presence of some degree of radioactivity. If he has the interests of his men at heart, he must know approximately how long they can work safely in this contamination, or at least know how to find out how long.

If he does not know this, his men will become unnecessary casualties and he cannot expect them to follow him with any confidence in a nuclear war.

Every Sapper officer should be able now to work out the dangers of such a situation. The calculation is not difficult and is concerned only with two things, the rate of absorption by a man, or dose rate, measured in roentgens per hour, and the total dose received over a period, measured in roentgens.

FIG. 1



In Fig. 1, the total dose absorbed by a man who enters a radioactive area at time A and leaves at B is represented by the shaded area.

The actual dose rate at any time can be measured with instruments, but it is also necessary to know the approximate time at which the explosion that generated the contamination took place. Then the position of time A in relation to the time of burst can be established, and the right piece of the

curve used. If the burst were recent then the decay rate would be high, whereas if the burst occurred many hours earlier it would be low.

The radiac calculator issued to units is designed to solve this problem. With a little practice it becomes easy to use. If it is not available in large enough quantities, a few specimen doses at selected time intervals can be extracted from it to give the officer a general guide.

It will be noted that if the time of the original explosion is not known, which may often be the case in practice, then the officer must work out the decay rate for himself by taking readings of the dose rate at fixed time intervals. It will be desirable to do this in any case, so as to check the theoretical figure.

In general, it must be remembered that the theoretical calculations are only intended as approximations to enable an officer to plan roughly for how long he should expose his men to contamination.

Having established the doses that his men have taken, or those that they will have taken if they continue working in contamination for a certain period, the officer must also know roughly how dangerous such doses are. It seems that not even doctors who are familiar with the subject can say with any certainty what the effects of radiation on the human body will be, apart from the cliché that all amounts of random radiation, no matter how small, are harmful. However, every officer should be familiar with the effects of radiation upon the human body that are given in service manuals.

One final fact about radiation should be understood. It is not comparable in any way to a virus or bacteria and the body does not therefore build up any resistance to it. Radiation represents energy and its effect is to do work on the body, more in the way that a blow from a fist or a bullet applies energy to the body. If it is looked upon as a series of very small projectiles, its effects are sometimes more easily comprehended. The body can recover from radiation, just as it can from a bullet, but it never recovers completely and there is always a residual effect. However, this does mean that doses taken over a long period are not so harmful as those taken all at once.

Protection

It is imperative that men who have to work and fight in radioactive areas should not be exposed to unnecessary doses. For instance, when they are resting they should not be receiving doses from some explosion that may have happened a hundred miles away, unless tactical necessity dictates otherwise. To save themselves they must have some knowledge of the protective effects of materials. For example, wood hardly alleviates radiation at all, so commanders' caravans will be no great asset in an atomic war. A roof of 18 in. of well-packed earth will be more conducive to healthy rest.

The degree of protection afforded by materials is usually given in terms of "half values", that is the thickness required to reduce any given dose rate by half. Of all the mass of figures available, it is only necessary for most purposes to remember that for soil. It depends on how well-packed the soil is, but between five and nine inches of it will reduce dose rates by half.

Thus there is no reason why men who have to stay in one place, even if that place is in a potential enemy target area, should not protect themselves. A cover of 3 ft. of earth will reduce a dose rate by about 95 per cent.

It must also be emphasised that Sappers are not only particularly susceptible to fallout dangers but also to those of flash. Even infantry in defence

can be protected by thermal shields to a very great degree and for most of the twenty-four hours. Sappers working in the open should, as a matter of routine, keep the skin covered. This is not a difficult problem from the material point of view, although it merits a special design of head-dress, but it has a disciplinary and training aspect that should be enforced in peace, long before an atomic war breaks out. Perhaps all ranks of field squadrons should sport beards in peace!

Conclusion

Finally, it should be understood that the dangers from atomic explosions, both to men and equipment, can be very greatly reduced by planning and training based on knowledge and experience. If we are not completely up to date in all that this implies, we will suffer huge penalties in the event of war.

Whither the Corps

The article, headed "Whither the Corps" and published in the December 1958 Journal was discussed at the recent Conference held by the Engineer in Chief. It is his wish that a record of these discussions be published in this issue of the Royal Engineers Journal.

An abbreviated record is set out below.

The article has also produced a number of "letters to the editor" which will be found at the back of this edition. They represent the personal views of the senders. They cover a wide field from the spirited defence of the pre-war excellent Establishment for Engineer Services to the most thrustful of combat engineer's views and include also the opinions of a Sapper officer who retired from the Service to take up what he calls "real engineering".

An article by a young Sapper officer, also produced in this edition of the Journal, gives a vivid account of Works Service tasks carried out during the recent Jordan emergency, tasks which Sappers must be capable at any time of undertaking at short notice.

In the "Technical Notes" of this edition of the Journal, attention is drawn to the Journal of the Society of American Military Engineers' Journal for September/October, 1958, which sets out the world-wide works service commitment of the American Corps of Engineers. *Editor.*

An Abbreviated Record of the Discussion which took place on 11th November, 1958, at the Engineer-in-Chief's Conference at Chatham

Brigadier J. B. Brown (D.D.F.W.) introduced his paper which was subsequently published in the *R.E. Journal*, December, 1958, at pages 352–362.

Major-General H. C. W. Eking, C.B., C.B.E., D.S.O. (C.E., B.A.O.R.) opened the discussion in the following terms:—

"I feel I am entitled to speak as I must easily be the most untechnical Sapper of my rank in existence. I agree with much that Brigadier Brown has said and written but not everything. I am surprised that amongst the pro-

fessional skills that he required of a Sapper, he did not require any particular military knowledge. I believe that to be wrong. Yet I agree with what he says on the question of 'soldier first, Sapper afterwards,' too much lip service to this may land us in the sort of difficulties we now face. I would put soldiering as one of the professional skills of the Corps, in Group I (with civil, structural, mechanical, and electrical engineering) because I do not believe you can do your job as a military engineer unless you have really sound basic knowledge as a soldier.

I believe we are suffering from a swing of the pendulum. In the early years of this century we were very good professional engineers and our reputation was high in consequence. The swing in the other direction was not our fault, though possibly we could have seen it earlier and have taken corrective measures. During the war, as Brigadier Brown said when referring to the economics of engineering, there was inclined to be emphasis on the soldiering side and getting the job done quickly, as opposed to getting it done in the most economical way. On those occasions the soldier has been at an advantage over the engineer, because the latter's conscience has pricked him to try to do a more perfect job and he has perhaps taken a little longer. Merits as an engineer have not necessarily been appreciated by the rest of the army, whereas the efforts of the officer who did the job quickly, but not so perfectly, were much appreciated.

We are now in the position of having a large number of senior officers who did not have the opportunity of the technical education available nowadays. The Universities were filled to capacity following the 1914–18 War. In a way this is a bad example to the younger generation, who naturally say 'I am invited to get an A.M.I.C.E., B.Sc., or B.A., and yet many senior officers in high appointments in the Corps have not got these qualifications; so perhaps it is not really necessary. They got on all right, so why should I exert myself.' Again the mystic letters '*psc*' are seen after the names of many very senior Sapper officers and the natural inference is to rate this qualification higher than engineering qualifications. These are influences which need adjustment. I think though, we have got to be just as careful in making that adjustment to see that we do not go too far, in the other direction, towards the technical side. We have got to get a sensible balance.

I believe we want to give junior officers more practical engineering. I am not worried about the more senior officers, engineering degrees may be an asset to them, but they do not need to use detailed engineering knowledge to the same extent as junior officers. The senior officers need organizational powers and fortunately for them, these are gained in large measure through ample military experience.

We have got to get much more engineering experience for the junior ranks of the Corps. I do not believe that can be done by attachments. They have got to be given jobs. I myself would very much like to see Mr. Gibson and Mr. Geraghty using more junior officers in the Civilian Works Organization and giving them practical experience; in addition to the quota of officers who will be regarded as a reserve for limited war.

The question of 'Other Ranks' is more difficult, because we have got to find work for our tradesmen, and the only way of doing this satisfactorily is to employ units on really practical jobs. But with the manpower ceiling imposed on us I do not believe that any field unit has got sufficient men to enable it to act really successfully as a contractor. Again we have not sufficient

units to enable us to jettison our many other commitments and put a unit exclusively on a works job. The problem is very difficult. I can only suggest that there might well be a case for asking for a limited rise in the manpower ceiling to allow us to keep up the trade skill of other ranks. However, I know any suggestion of an increase in manpower is looked upon in horror, particularly by those who have the problem of negotiating it."

Brigadier G. W. Duke, C.B.E., D.S.O., B.A. (Commandant S.M.E.), who spoke next, said that some of the views he would express were those of officers at the S.M.E. with whom he had discussed the paper. He said *inter alia*:—

"The higher our professional skill, the higher will we stand in the eyes of the outside world. But we must consider what the Army requires of the Royal Engineers. The Army too is at a cross-road, there is drastic rethinking going on to encompass nuclear war and yet compete with the tiresome business of cold war. The Army might possibly consider that they only require combat engineers. I agree with Brigadier Brown that whatever sort of war we fight, professional engineers will still be required, but the rest of the Army may need some education to be convinced of that.

Do all our officers need to be professionally qualified? Before the war the answer was 'Yes'. Yet after obtaining degrees few of us had the opportunity of practising our professional skills. However, now there are two types of officers, those who are capable of getting degrees and those who are not. The latter will probably make good combat engineers and with regimental and staff experience make our councils heard in the rest of the Army. I support General Eking, the amount we are listened to in the Army depends firstly on our skill as soldiers and secondly on our professional skill. In the U.S. Army the purely professional skill of the U.S. Army Engineers is probably higher than ours; they have better opportunities, but I doubt if their voice is heard so well in the U.S. Army. If we concentrate too much on professional skills we may lose sight of what the Army requires of us as soldiers as well as engineers."

Brigadier Duke then spoke of other ranks and agreed whole-heartedly with General Eking and Brigadier Brown, that other ranks must be given opportunities to practice their trade skill on practical works projects. He pointed out our disadvantage vis-a-vis Royal Signals and R.E.M.E. who found no difficulty in employing enlisted tradesmen at their trades. He thought that it would be easier to give men practical work at their trades when we are able to get away from the one-year "training cycle" imposed on us by National Service.

Lieut.-Colonel B. A. E. Maude, M.B.E., R.E. (Commanding 37 Fd. Engr. Regt.) said that it was his opinion that the primary role of the Corps was to be field engineers, and to do that well it was impossible to undertake the additional responsibility of Works. In his view there was no need for large numbers of skilled tradesmen as the emphasis would be on combat engineers.

Lieut.-Colonel W. G. F. Jackson, O.B.E., M.C., R.E. (Commanding the Gurkha Engr. Regt.), disagreed with Lieut.-Colonel Maude. He said that Works Services were originally a vehicle for training the engineers in peacetime for tasks likely to be met in war. Nowadays there is little similarity between works services in cantonments and the construction of roads and airfields in war. In addition the existing trade structure showed an over abundance of Painters and Decorators and Carpenters and Joiners, whereas the emphasis should more correctly be on the mechanical trades. He said that

it was necessary to find a new training vehicle for exercising units, particularly in peace. Suggested charter might be:—

Field Squadrons. Field construction work, equipment bridging and similar work likely to be met with in the brigade group.

Corps Field Squadrons. Major works projects such as Christmas Island, Kedah Roads, etc.

Works Services. The attachment of individuals to major civil works projects and the use of specialist advisory teams on major military works projects.

There was further discussion during which a number of officers spoke, and several had to be denied the opportunity to do so due to lack of time. Space does not permit a full report of what was said.

Major-General H. H. C. Sugden, C.B., C.B.E., D.S.O., M.I.C.E. (Engineer-in-Chief) concluded the discussion by reminding those present that the basic requirement for a military engineer was technical ability reinforced with the experience and intuition of a trained soldier.

Works Services in the Field—Jordan, 1958

By Captain D. I. Knight, R.E.

Move to Jordan

After several false starts, we flew to Amman on the 1st of August to join the Parachute Brigade. The Chief Engineer had briefed me in Nicosia. My party of ten included four senior N.C.O.s: two Clerks of Works (Constructional), one Clerk of Works (Mechanical) and a Storekeeper. We were a Works Task Force for Jordan. Our role was to do all works services in Aqaba, to assist the Parachute Engineer Squadron in Amman in any way we could, and to control engineer stores in Jordan. Engineer stores were to be bought locally, anything not available being obtained by sea from Cyprus. My headquarters and engineer stores were to be in Aqaba.

I went to Nicosia airport, and saw my driver put on a Hastings with his Land Rover and trailer—the trailer piled high with survey equipment, tool kits and stationery. The rest of us flew an hour later in a Beverley. My first impression of Amman airfield was one of bustle and great confusion. It was dark, but alive with people and vehicles, their noise drowned only by the roar of aircraft engines. My driver greeted me as I got off the plane and I quickly got in touch with the Engineer Squadron. Their commander welcomed us into his camp for the night, and offered a Champ and trailer to take us to Aqaba next day. He had a troop detached there, and wanted the Champ taken to them.

Amman

He explained that the Brigade was in Amman living under very cramped conditions on the airfield with the R.A.F. At Aqaba there was an infantry company, and various administrative units, ready to man the line of communications if the air lift failed. In Amman the Squadron was busily engaged

putting up a large fuel storage installation for the R.A.F., and building essential camp structures for the Brigade as fast as it could. There was some permanent accommodation, whose maintenance was supposed to be done by the Jordanians.

When I saw the Squadron I was immediately struck by their terrific spirit, and great sense of urgency. It was dark, but the party on the fuel installation were only just returning. They were a proud, tough lot, but always friendly and most co-operative. They were living under fairly rough conditions. Their kit and some of their men were in very crowded Nissen huts, but most of them slept outside in bivouacs. Their kitchen was a hydro burner under a draped camouflage net. Their only comfort was a block of showers and washhand basins. The hurried atmosphere was infectious, and my party were soon rushing with the paratroops to get their evening meal and bed down on the ground wherever they could find space.

The Hill Road to Aqaba

Next morning by seven we were on the road to Aqaba, the two light vehicles and their trailers fully loaded with men and kit. The route we took was along a mountain road, relatively straight on the plateaus, but twisting tortuously where it went down and up the sides of deep wadis. Two wadis were particularly deep, both leading to the Dead Sea which was clearly visible in the distance. For half its length the road had a bitumen surface, but extensive road works were in progress, and driving along the uncompacted new formation often required four wheel drive.

Amongst the weather beaten rocks and desert sand all round us it seemed that nothing could live, and yet we saw the occasional camel, and sometimes a solitary Arab striding purposefully across the desert. We selected a particularly desolate spot to eat our "compo" lunch. We were hot and very dusty. A few determined tea drinkers lit their hexamine stoves and brewed tea in their mess tins, but most of us were content to drink water. To our surprise a couple of Arabs suddenly appeared from nowhere and sat about twenty yards away quietly watching us. They stayed there till we moved off, when we saw them dig up our refuse pit.

The journey was 285 miles, and it was after seven when we reached Aqaba in the dark. A sprinkling of fine dust all over us made it look as though we had just stepped from a flour mill. There was no need to explain that we had just arrived.

Aqaba

The Aqaba Sub-District Commander warmly welcomed us, and the Camp Commandant showed us where we could live. It looked most unattractive, but we soon found that nearly everyone was living under very cramped conditions. We decided to visit the Troop from the Engineer Squadron, who we had been told lived on the beach.

We found them about a mile from the main camp, near the air strip, living in relative luxury. Six large Nissen huts bordered two concrete terraces, some twenty yards from the sea. It had been the N.A.A.F.I. run British Army bathing club, and was well appointed with kitchens, showers and latrines. We decided to stay with them. Aqaba was extremely hot, and it was most pleasant sleeping by the sea with the clear desert sky overhead, always crowded with stars.

Next morning I discussed Aqaba and its engineer problems with the Troops' two officers. They were waiting for stores to build fuel tanks at the Aqaba oil storage installation. Meanwhile, they were responsible for the sand air strip which was being maintained by the Jordanians, and they did any vital works services. But most of their time was spent doing military training, and keeping fit.

The Aqaba Air Strip

I looked first at the air strip. It was a flat stretch of desert about 1,200 yards long, with a line of hydrants running down the centre. A diesel pump on the beach fed the hydrants with sea water, and a party of Arabs watered the strip daily using long lengths of hose pipe.

The daily routine was to remove ruts by dragging a "baulk" along the strip, towed by a tractor. In fact three unopened coils of dannert wire were used, and found more effective than the normal timber baulk. The strip was then watered and rolled, first by a wobbly wheeled roller and then by an 8-ton smooth wheeled roller. The salt from the sea water bound the sand and an extremely hard surface crust was achieved, on which a Land Rover virtually left no track marks. Soft spots occasionally developed which had to be dug out and filled with "mud"—this was the name given locally to a sandy clay found further up the wadi.

In the old days of the British Army, the strip had been regraded about every six months, one side at a time. This destroyed the hard top crust, but was necessary to restore the level surface, that slowly became undulating under erosion from the wind. Jordanian air traffic, at two planes a week, had made one side of the strip sufficient. The other side had been abandoned, and sand dunes and camel thorn had developed, which the Sapper Troop were removing with their grader. The increased air traffic, with one or more planes daily, made the second side essential.

Accommodation in Aqaba

From the air strip I went to the main camp. A number of huts and married quarters had been taken over from the Jordan Army. They had all previously been built by the British, and the usual army timber and corrugated iron ablution shelters, latrines and kitchens were dotted about the area. There were also concrete bases for tents, but no tents were in use. The garrison preferred to accept over crowding and live in buildings.

The huts were mostly solid-looking mud brick shells with curved corrugated iron roofs. Light metal tie bars braced the tops of the walls, and to these were crudely attached ceiling roses to provide electric light. But there were no electric light bulbs or fans. Hooks in the roof showed where fans had been, but the British had removed them all when they left. Now in the extreme heat of Aqaba summer, the British Army did not have a single fan.

The married quarters were Ctesiphon huts, British built structures rather like Nissen huts but with their curved surfaces made of a 2-in. shell of concrete. These huts were shaded by "sun hats", timber structures supporting a local rush matting, which completely shaded the building. The quarters had been fitted with air conditioning sets, but again the British had removed them. Even without fans, the Ctesiphon huts shaded by their sunhats were remarkably cool. The iron roofed buildings were like ovens.

Electrical and Mechanical Installations in Aqaba

There were no refrigerators, and the only ice available came from the local fisheries who charged five times the current Cyprus price. A 20-ton and two 50-ton cold stores had been installed by the British Army but not used since, and now required recharging with gas and overhauling before being used again. The British ice plant had been moved by the Jordanians to Zerka.

Electricity and water were supplied by the Jordan Army, using the late British Army power station and pumping gear. Water was chlorinated by an ingenious system devised and installed by my clerk of works during previous service in Aqaba. The suction from a venturi in the main pipe line sucked a chlorine solution into the pipe, the quantity being proportioned to the flow.

A small sullage disposal system existed. Sullage drained to a tank from which it was pumped along a 4-in. pipe to the sea, about half a mile away. Two single stage centrifugal pumps were used instead of a sullage pump, but their filters had been removed because they blocked so frequently. Instead, the pumps were allowed to slowly become blocked up, and every few weeks a fitter had completely to dismantle them and clean them out. While the fitter was at work the tank overflowed. This worried me, till I later discovered that between the pump and the sea several sections of pipe were missing, so that even when the pumps worked they merely formed a pond a few hundred yards further on amongst the sand dunes.

The Aqaba Oil Storage Installation

From the main camp I went to the oil storage installation. This consisted basically of four 500-ton tanks, and a system of 4-in. pipes that allowed each tank to be connected to a filling point, or to a floating pipe line which led to a sea tanker.

During former leisurely times, this system had worked well, but it was now being severely over loaded. It appeared that an appeal for oil for Jordan had been answered by every tanker in the area. The consequent over crowding in the gulf was more than the port authority could cope with, to the disgust of the tanker skippers. At first the service authorities appeared reluctant to take command of the situation, but ultimately a Royal Naval frigate took on the task of berthing ships and restored a considerable amount of order.

Most of the tankers drew too much water to approach the floating pipe, and a system had been adopted using a smaller tanker as a lighter, ferrying oil from the big ships to the pipe. Tankers normally discharge several types of oil at the same time, along different pipes. A single floating pipe, and a complicated system of accounting, made discharging oil a very slow business. There was only one opening into each tank, which prevented vehicles filling while tankers were discharging. There were no pumps in the installation, tanks being filled by the ship's pumps and emptied by gravity.

The installation was unsuitable for storing jet aircraft fuel (Avtur), as contamination with water or other oils was unacceptable. It was the custom for tankers to pump sea water along the pipes to clean them, when they changed from pumping one type of oil to another, and the tanks all had water bottoms. The bulk of the water was removed by water-separators between the tanks and the vehicle filling point, but this was not good enough for Avtur. Some independent system was required, which would be pro-

vided by tanks to be built by the Sapper Troop, and another ship to shore pipe line. Stores for this pipe line I had seen stacked on the docks.

I had been warned that a lot of people had interests in oil, and I soon found this was true. An American "Point IV Aid" team had been hurriedly diverted to the installation, where they were laying a new 6-in. diameter pipe from fresh openings in the tanks down to the sea. The pipe was then to run along the sea bed to a vertical riser, which would be approached by the large tankers. This team had been prospecting and drilling for water in the area, and the American in charge kept saying, "I'm only ah-used to drivin' voitical pipes. These durned horizontal pipes just ain't ma line o' country." However, they had set up a very efficient production line, and were welding the large pipes together and booming them forward with a winch at a most remarkable speed.

The Sapper Troop Leaves—and Work Starts

Having spent my first day in Aqaba investigating the engineer problems, I returned to our beach camp that evening to find the Sapper Troop packing up. The arrival of the fuel tanks had been delayed, and the Troop was to rejoin its squadron in Amman. They left during the next few days, some being flown up on the daily aeroplane and the remainder leaving with their stores by road.

We at once engaged a small labour force, which eventually rose to twenty-five Arabs. My clerks of works had all been in Jordan before, and soon found most of the tradesmen that we required. We never found a refrigerator mechanic and the only electrician we found was almost useless so that most of the electrical and mechanical work had to be done by my supervisory staff. Two local Arab shop keepers agreed to work as contractors, and carry out any work outside the capacity of our own labour. Another contractor was later found prepared to take on electrical work. Some engineer stores were available in the local shops, but most had to be ordered from Amman. Prices of stores were very high but labour was cheap.

Anything not readily available was ordered by signal from the W.D. engineer store depots in Cyprus, and was received by sea about a week later. We set up an engineer store on the docks to receive and issue these, and also to house a large number of stores that had been sent ahead of us. This included the ship to shore pipe line, a 27·5 kVA. trailer mounted generator, various pumps, some plant for the air strip and a selection of useful fittings. The air lift had stopped a few days after our arrival, so that all military stores had to come through Aqaba.

The amount of work we were required to do rapidly increased. Fans and refrigerators were installed. Numerous locks were fitted. Latrines were converted from Asian to British type. A mild outbreak of dysentery was followed by an intensive drive on flyproofing. The labour force on the air strip was increased and a new pump installed. The two 50-ton cold stores were put in use. But most of our work went into trying to keep the dilapidated camps useable. A lot of the underground plumbing was in very bad condition and really needed replacing, but until the length of our stay was known no large expenditure of this kind could be considered. On the 15th September we changed from war accounting to full peace time accounting with certain special powers.

Developments at the Oil Installation

At the oil storage installation, vital decisions were made the day after we arrived. The Parachute Brigade Commander gathered all available oil experts together for lunch at the Aqaba rest house. The word "expert" had a rather wide application, covering the three services and a lot of civilians.

We ate outside the rest house on a terrace, under bedraggled grape vines, hanging from a rickety wooden framework. The contrast between our fairly formal lunch and the primitive surroundings was high-lighted when one of the civilian "experts", who was staying at the rest house, suddenly appeared in his pyjamas.

During lunch it was agreed that a separate system for Avtur would be obtained by allotting it one of the existing 500-ton tanks, by constructing a new vehicle filling point, and by using the new Point IV Aid pipeline once it was completed. It was also agreed that the British Army ship to shore pipeline stores, together with some rubber hose from the Admiralty, would be laid alongside the Point IV Aid pipe, to enable large tankers to discharge two fuels at one time. Finally, it was agreed that the Point IV Aid team would do most of the work required.

The new vehicle filling point was soon completed, but before the Point IV Aid pipe was finished it was decided to adopt a different system. The tanker skippers had objected to having to come alongside a rigid vertical pipe in the sea, in view of the restricted space available to manoeuvre their ships, and the lack of tugs or moorings. Instead, a second floating pipe was made which allowed the small tanker, being used as a lighter, to discharge two types of fuel. One of these pipes was kept for Avtur.

Winterization—Amman

On our fifth day in Jordan I was summoned to Amman. There I was told that plans and financial estimates were required, to prepare the Amman camps for the winter. Amman normally has about five falls of snow and a lot of rain in the winter. To make things worse, the "cotton soil" round the air field, which causes an unpleasant summer dust, becomes deep mud in the winter.

There were five major units including the headquarters, and half a dozen minor units. Each of the major units had a two-storey permanent construction barrack block, built by the R.A.F. in earlier years. This provided all facilities for their officers and sergeants, and most of their offices and stores, but little else. The minor units had a few corrugated iron huts. The Parachute Engineer Squadron had very rapidly put up essential camp structures for all units, but many more were needed.

The Brigade staff gave the requirement in very broad terms, which included floors and electric light in all tents. Our first step was to prepare a staff table, giving the requirements in considerably greater detail.

The Clerk of Works whom I installed in Amman had been there before, and led me to the old British Army term contractor. We got together in his house and steadily went through our detailed staff table calculating the prices of all the items. We also discovered what stores were not available on the local market. Some were special army stores like Nissen huts, but others were ordinary items such as electrical power poles which the closing of the Syrian and Lebanon borders had made unobtainable.

We examined the power station, the water pumps, and the distribution systems. The R.A.F. had put electric light in some of their tents, but the air field voltage had dropped so alarmingly that the tents had to be disconnected. There was a water shortage, and the Jordan Army who controlled water turned it off for long periods each day.

In under a week we produced sufficiently detailed plans, and an estimate of £100,000.

Arrival of a Troop from 23 Squadron

About this time, another Sapper Troop arrived in Aqaba from Cyprus. Like the Parachute Troop they arrived expecting to build fuel tanks, but after a short stay they went up to Amman and came under command of the Parachute Squadron.

Visit by Winterizing Teams from Cyprus

At the end of August a Q(Quartering) winterizing team spent four days in Jordan. They examined the problem and found that the amount of "winterizing" requested by the Parachute Brigade was extremely Spartan by Cyprus standards. The Brigade agreed to make their requirements conform more closely to standard Cyprus camps, which increased the estimate to £210,000.

In the middle of September the Chief Engineer's winterizing team visited Jordan for a week. The team included the Chief Engineer himself, and his senior planning and quantity surveying officers. They arrived for lunch on Saturday and over the weekend saw the sites and discussed problems with the Brigade staff and heads of services, and with the Commanders of the British and Jordanian Air Forces. In doing so, considerable concessions were agreed which reduced the estimate to £110,000 without any serious reduction in standards.

In two days the calibre of the available contractors was investigated, contracts were prepared and tenders were sent out. By Thursday evening, negotiations had been made with the lowest tenderer and the first contract was let. A second large contract was prepared concurrently, and let before the team left.

News of the Withdrawal

Soon after the contracts had been let, the British withdrawal was confidently forecast by the press. This acted as a spur to both contractors, who were determined to complete as much of their contracts as they possibly could. Seldom before have British Army contractors ever worked so fast, and their work consequently had to be most carefully scrutinized.

At this time the Brigade prepared for the possible withdrawal. Their plan included doubling the size of the Aqaba garrison, which required us to put more camps into commission—and only the really derelict ones remained. Numerous small contracts were let, and a lot of work was done by our labour force.

As work increased in Aqaba and Amman it became more and more difficult to control both places. I became such a regular passenger on the aeroplane that the R.A.F. threatened to sell me a season ticket. After the Amman contracts had run two weeks, another officer arrived as D.C.R.E. Amman with a staff of four.

The next day a signal was received ordering the contracts to be terminated.

All work complete was measured, and contractors were ordered to state whether they had any additional claims. One of the contracts was to provide roads, and the contractor was able to show that he had large quantities of stone specially crushed and graded to conform to our specifications, whereas normal Jordanian standards were much lower, an "all-in" mix generally being acceptable. Various other claims were investigated, and where quantities were involved they were measured. Final settling of the claims was done by our quantity surveyors in Cyprus, in conjunction with the Command Secretary.

The Desert Road

After I had handed over in Amman to the new D.C.R.E., I had some difficulty returning to Aqaba, as the normal Valetta had had a slight accident. Only road transport remained, and the hill road that I previously used had been closed. I accepted a lift with one of the many road convoys going down to Aqaba on the desert road—a journey I will never forget!

The term "road" is a bit misleading. It was an expanse of desert up to five miles wide, that lay between a line of telegraph poles and the railway. The whole area was deeply rutted, and covered by a very thick layer of fine dust. The cloud of dust thrown up by the vehicle ahead was so dense that it completely hid the vehicle, and if one got engulfed in it one had to stop and wait for the dust to settle. Convoys drove along in a staggered line, each vehicle following a path to one side of the vehicle ahead in order to avoid its dust. We drove all the way at ten to fifteen miles an hour, being constantly thrown about by deep holes and ruts concealed by the heavy blanket of dust. In some places the desert was hard and strewn with rocks; in others it was soft sand requiring four-wheel drive. But everywhere, there was dust. Many of the vehicles were shaken to pieces. The 3-ton lorry I travelled in broke a spring.

In the day time it was pleasantly hot, but at night it was bitterly cold with a very heavy dew. The journey took us two full days, driving from first light each day till it got dark, and not stopping for any meals. We had a main meal in the evening, and in the morning before it was light we gathered round a big fire for our breakfast. We were all rather relieved to reach the metalled road leading into Aqaba.

The Withdrawal

The Brigade withdrawal plan went extremely smoothly. In general, vehicles and heavy stores went by road to Aqaba and then by sea, while most units and the bulk of their equipment went by air. The United Arab Republic had welcomed our withdrawal, and over-flying Syria and Lebanon presented no problem.

The high cost of road transport from Amman to Aqaba made it uneconomical to recover many of the engineer stores. Instead D.C.R.E. Amman sold most of them by public tender. The more valuable items, and certain stores specified by G.H.Q. M.E.L.F., were sent to our Aqaba engineer store and then shipped to Cyprus. In Aqaba, everything that could easily be recovered was loaded on to the L.S.T.s, for which a large number of crates were required.

As British troops left, accommodation was formally handed back to the Jordan Army. During the last few days in Aqaba most administrative troops lived on the ships, which simplified the hand over.

Farewell

On 2nd November we handed over the last building, and then gathered on the docks for a farewell parade. Men of the 1st Cameronians formed up facing men of the Jordan Arab Army. The King of Jordan first visited naval ships in the gulf, and then came ashore and stood on a saluting base. Much presenting of arms and saluting followed, after which the King and all officers walked on to the tank deck of an L.S.T., which was moored with its enormous bow doors open, some ten yards from the saluting base. A champagne party, at which the King abstaineously drank orange squash, made a fitting end to our expedition. The party ended, the L.S.T. closed its bow doors, and we steamed into the Gulf.

Looking back on Jordan revived many happy memories. Most of us had found time to explore the holy places in Jerusalem, and to visit the ancient, rose-red city of Petra. In Jerusalem it was interesting to find that the site of Christ's tomb which the Church of England recognize had been discovered by a late Sapper officer, General Gordon. The sub-aqua life of the Red Sea is probably the most fascinating in the world. In Aqaba we had spent many hours swimming with goggles on, gazing at the brightly coloured coral, and shooting fish with spring-loaded guns.

We were all glad to be going home, but were leaving much the richer for the many fascinating experiences gained during an intensive three months visit to the country.

Lessons Learned

The Jordan crisis brought out the need for a Works Team, able to move at short notice in support of an emergency force. The need will still exist once the works service has been civilianized. This team should include tradesmen such as refrigerator mechanics and electricians, as they are unlikely to be found in less advanced countries.

Considerable assistance was obtained from the local knowledge of Clerks of Works who had been in the country before, and from the immediate stores backing by engineer stores depots in Cyprus.

Decisions on large engineer expenditure, under most uncertain conditions of this kind, will always be given late. This delay was offset by senior engineer officers visiting the site, and rapidly letting contracts on the spot.

Winter in Cyprus

By Major B. J. Coombe, G.M., R.E.

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My story is quite typical. It is the story of a few months in the life of a field squadron of Royal Engineers—an unexpected interlude of operations overseas which occurred in the middle of an otherwise peaceful and unexciting tour of duty in England. I was lucky enough to be the Squadron Commander.

It was just one more of those sudden moves which have become quite a feature of Army life since the end of the war. One day we were enjoying a

day on the ranges where our most serious problems concerned the inability of Sapper Dormouse to hit the target, and the next day we were preparing to move to Cyprus in five days' time.

There is plenty to do when a move like this occurs. On top of the packing and the loading, about ninety reinforcements arrived and had to be fitted into the Squadron. They had received only basic training and seemed a motley addition to take into the blue.

But the thought of going off on our own overseas was just the thing to spark off a tremendous enthusiasm, particularly amongst the younger men. The spirit of adventure is as strong as ever it was, and the place was full of smiling faces.

So, full of high hopes and excitement, we set off. A typical example of green, inexperienced and untried troops going off into the unknown; but fortunately not entirely inexperienced. Most of the officers and N.C.O.s and a few of the men had seen service in the Middle East before, and so the worst pitfalls of foreign service could be avoided provided the inexperienced newcomers could be educated in time.

The excitement of anticipation tends to become a little unreal and particularly so when fanned by the lurid tales of terror and trouble which have filled the newspapers for so long. Cyprus, we thought, was seething with terrorists, bombing and machine gunning anyone who turned his back for a moment.

The anticlimax of reality was like a cold shower on our heated imaginations. To all outward appearances Cyprus could not have been more normal. It was difficult to see what all the fuss was about. Even the bars and the night spots were all open and the troops were allowed to come and go as they wished.

At least it was appropriate that whilst exploring the cabarets of Nicosia during their first evening, two of our more rustic sappers should have a bomb explode at their feet. Fortunately the bomb made no impression on the two sappers although it suitably impressed the rest of the Squadron.

But we had not come out to Cyprus to play about; we had come to do a job of work. After the excitement of the sudden move the one thing everyone wanted was to get on with the job. We were now on our own and eager to prove ourselves.

Our role was not to join in the apparently dramatic and newsworthy actions against the terrorists; ours was to be a much humbler, more homely task. We had been sent out to help build the camps for the large numbers of troops who had suddenly arrived on the Island. Winter was approaching, and winter in Cyprus is cold and wet and windy. Thousands of troops were living in bleak tented camps and improved facilities were badly needed to keep them going throughout the winter.

We set up camp near Nicosia but soon detachments were scattered across the Island; a few huts to be built here, a cookhouse to be erected there, a special camp to be built somewhere else. Not a very glamorous collection of jobs but at least the plumbers, the carpenters and the bricklayers could enjoy working at their trades.

Every man was fully employed either working with a detachment or out on the road keeping them supplied with stores and materials.

It was on the road that trouble first arose. One Troop was working on

the 6,400 ft. high summit of Mount Olympus above the mountain village resort of Troodos.

The road up to this detachment twisted and bent for twenty miles as it climbed up through the mountains. The wild country round Troodos was a positive playground for terrorists and every one of a thousand corners offered ideal ambush positions.

But things were still comparatively quiet and we were lucky. Every trip meant running the gauntlet but nothing happened to us.

Then one day a bridge was found blown and the road blocked. This was a serious matter for us, as the Troop had to be kept supplied and this was the only direct way up. We were ready to build an improvised bridge immediately, but instead it was decided that repairs would be done by contractors and would take a fortnight.

Another route had to be found. After consultations a secondary earth road was suggested provided our vehicles could get along it. It was through some of the wildest country on the Island and seemed of doubtful value, so I decided to send out Martin, our H.Q. subaltern, to reconnoitre it next day. It was a long trip, about sixty miles each way, but Martin was due for an outing anyway as he had been working round the camp and had not seen much of the country.

The blown bridge having closed one road I could not help wondering where the next would be blocked and whether Martin would get through. It was a great relief when a signal arrived at midday to say that he had arrived at Troodos safely and that the road was mountainous but passable to our vehicles.

Our worries seemed to be over for the time being. Later that afternoon, just as we were beginning to expect the party back, a telephone message was received from a police station at a village on the road.

The message was brief—"Patrol ambushed; Champ missing."

It was a bad moment and not made any better by the difficulty of getting any more information either by telephone or wireless; anyway it was already too late and too far away to do anything from our base in Nicosia.

Eventually it was established that the Commandos were looking after the party but that a driver had been killed. It was not until next day that the full story of this remarkable ambush was known.

The two vehicles of the patrol were on their way back with the Champ in front and the escort vehicle behind. The escort vehicle had fallen back some distance and the Champ, on rounding a bend, was fired at from front and behind. The driver was killed instantaneously and the Champ plunged off the side of the road down the steep slope of the hillside until it came to rest on a terrace thirty feet below. Martin and his sapper orderly were thrown out in the crash and rolled down the slope. They lost their Sten guns but miraculously were not seriously hurt. By the time they had picked themselves up a dozen armed men were coming down the hill towards them tossing grenades down the slope as they came. It was a nasty position to be in; in the heart of the mountains, miles from any help, hopelessly outnumbered and outgunned and on an open hillside which offered little cover except scrub and rock.

The escort vehicle behind had missed the crash, and, thinking the Champ was still in front, had gone on. By the time the two sappers in it had realized

their mistake it was too late so they pushed on to the nearest military detachment for help.

Meanwhile Martin had to act quickly. He got hold of his orderly and together they started to run for it. Dodging bullets and bursting grenades they jumped from terrace to terrace and tried to get round the hill and out of sight without getting too far from the road along which lay their only hope of rescue. For nearly an hour the chase went on; two unarmed men alone on a hillside against twelve or more armed terrorists.

The odds seemed impossible and only the timidity of the terrorists saved the two by giving them a chance to keep their distance. By alternately hiding, crawling and bolting they managed to get away and eventually reached a village some miles down the road. But their troubles were not over. The villagers were sullen and unco-operative—all they got were dark, threatening looks.

Still keeping to the road, they walked on down the hill when, on rounding a corner, they surprised more men in an ambush position. On doubling back up the road yet more men appeared behind them. The chase was on again. As they scrambled down the hill more grenades burst around them, but this time suddenly the attackers drew away and they heard a car coming. Rushing up to the road again they just managed to stop the car in time, much to the surprise of the driver—an R.A.M.C. major doing a tour of hygiene inspections in his private car! He collected the two most grateful hitch-hikers of 1955 and so brought to an end the "battle" of Kyperounda. Just the sort of end to expect in a place like Cyprus!

As soon as the news reached them, the Commandos sent out a strong patrol; but inevitably the terrorists had melted away and only the evidence of the attack was left behind. Next day, whilst trying to recover the crashed Champ, the Commandos found buried in the road, underneath where their recovery vehicle stood, a big explosive charge fully prepared for firing electrically. Our little party had sprung a strong and carefully prepared ambush position which was probably intended for bigger fry.

After our rather carefree existence this action, which resulted in the death of one man and the miraculous escape of two more, naturally had a profound effect on the Squadron. Before, an ambush had been something that happened to other people: now we were up against it ourselves. EOKA, the terrorist organization, must not be allowed to get away with it so easily next time.

If the chance should happen again, we had a big debt to pay off, and were determined to give a good account of ourselves. Such was the feeling that grew in the Squadron, and steps were taken accordingly. A new and more aggressive ambush drill was worked out, the fire power of escort vehicles was stepped up, and an unusual concentration on the cleaning and servicing of personal weapons all helped to make everyone feel that they were playing their part. When a friend has been killed and you can do nothing but wait, it is some consolation to sit in your tent with your rifle across your knees, cleaning, cleaning and oiling . . .

But even before we had buried our dead another blow was struck at the Squadron. This time it fell upon a party from our Troop up at Troodos, who, almost isolated from the remainder of the Squadron, were having to rely on the Royal Marine Commandos in the area for food and supplies.

One of their trucks was travelling down the mountain road with a Commando convoy when a rock came rolling down the mountainside on to the road immediately in front of it. The driver swerved to try to avoid a crash, skidded, and went over the side. By the time the truck came to rest one man was dead and three more were badly injured. It seemed to be an obvious act of sabotage but no trace of the terrorists was found.

So the toll of casualties in the Squadron grew. Two men killed; two lives pointlessly and fruitlessly lost. Somehow or other the Squadron would see justice done. Everyone wanted to have a chance to hit back; clerks and storemen pleaded to be allowed out on escort duty; it became everyone's ambition to be out on those mountain roads with a chance of hitting back. A tendency to make unnecessary journeys had to be carefully watched. Such resolution was a new sensation for most. They had never experienced this feeling of tension and determination before.

Without realizing the change, they were rapidly developing the outlook of the fighting man instead of the citizen soldier. Those who, a few long weeks before, had been green and shy and irresponsible, were now becoming hard, determined and reliable. It was a transformation which, taking place as it did in the microcosm of one small independent unit, had an electric effect on morale. It was no less apparent because it had few outward manifestations. The routine went on as usual; the unexceptional routine of constructional work on the various sites, of moving stores and building huts. One day was very like another. The tension was not that of going into action, we were not there to do that sort of thing. It was the tension of being ready and waiting; waiting for an opportunity to hit back.

The opportunity did arise a few weeks later.

It was during a routine round of visits and I was on my way to visit a detachment working on the coast. We had come down from the mountains and having left the recognized "ambush area" the escort vehicle was sent home whilst my driver and I set off for a quick run to the detachment along what was supposed to be a "safe" road.

We had not gone very far when suddenly we were attacked by a burst of machine gun fire. I happened to be driving at the time and my driver, who was sitting beside me, collapsed in his seat. When the Champ came to rest under the lee of the spur we were driving round, I found that he was mortally wounded and that there was nothing I could do for him.

It was a strange twist of providence that the opportunity for which the whole Squadron had been waiting should have fallen to me. It was particularly bitter that my own well trusted driver should have been the one to die.

I got out of the Champ and climbed up the back of the spur to gain a vantage point where I could put into practise the ambush drill which we had so carefully planned.

When in position on the crest of the spur I found the gunmen grouped in the gulley below me, hardly thirty yards away. They took cover under a bank but could not get away and their shooting was wild.

This was the situation which one had hardly dared hope for. There, within range of my gun, were the men who represented the evil organization which had not only killed my driver but had already inflicted mortal losses on my Squadron. Time and time again, in ambushes throughout the Island, they had struck and got away unscathed. Now at last they were caught. I must not allow them to escape.

Even without much faith in my skill with a gun it seemed that I must hit something. At every glimpse I got of them I fired a burst, but the effect seemed to remain purely psychological. There were no indications that a hit had been scored.

When I discovered that I had emptied my second and last magazine and there were still no signs of a hit, it seemed that I had thrown away the unique opportunity that I had been given. I even tried a few shots from my revolver but that was obviously a forlorn hope. It was a frustrating and bitterly disappointing moment.

The gang was still caught but there seemed nothing more I could do except wait and hope that another vehicle might turn up. There were very few military detachments in that area, and anyway it was nearly lunch-time so I knew there would be little chance of anything passing for some time.

It then occurred to me that my driver's Sten gun and ammunition were lying with him in the Champ on the road below. The gang would probably make their escape whilst I went to fetch them, but it seemed to be the last hope.

It was whilst I was down on the road that the first vehicle came along; it was a civilian timber-lorry travelling towards Xeros, the nearest military camp. The driver could not understand English, but I hoped that my martial gesture combined with the sight of the ditched and bullet-holed Champ alongside would enable him to appreciate what was going on. At least it was comforting, as I climbed up the back of the hill again, to feel that there was a chance that some sort of message might get through. It was also comforting to hear occasional bursts of fire coming from the gang on the other side of the hill, which clearly indicated that they still thought that I was covering them.

Having taken the precaution of hiding the second gun in case they should search the Champ, I decided to work my way further up the hill away from the road and try to get round the back of the gang if they should withdraw up the other side of the spur.

The hill was not particularly high but I was not particularly fit. As I stopped halfway up to get my breath back, I could hear subdued voices coming from the other side; clearly they were moving away from the road and were probably making good their withdrawal. I scrambled on up and was just in time to catch them still in the gulley but not very far from a crest which would have taken them over the top and away. It was greater luck than anyone rightly deserved. The gulley was too shallow to offer them much protection and so once again they were caught. The range was still not more than forty yards so I started shooting again but by this time I had lost all confidence in hitting anything.

So my surprise was immense when one of their number started shouting "Don't shoot! Don't shoot!" and stuck his hands up. He climbed out of the gulley closely followed by two more. The sight of these three men walking out with their hands up produced a feeling of incredulous satisfaction. It looked too good to be true—a case of Walter Mitty come to life!

Such sentiments were short lived, as no sooner had I moved forward to cover the three men when a fourth opened up again with a machine gun from a hidden position in the gulley. It seemed after all that they were playing the old trick of pretending to surrender and then attacking with a hidden machine

gun. Once the gang split up there was no means of keeping them all covered from one position and I would be at a severe disadvantage. It was impossible to tell what tricks they might be up to next. I had no alternative but to shoot the three men who had come out of the gulley and they collapsed on the slope opposite me. I then concentrated on the tougher individual still in the gulley. He was badly placed but he kept on firing, so I gave him all I had left of my Sten gun ammunition.

After a pause he too put up his hands shouting "Don't shoot, I surrender!" and I called to him to come out.

One of the first three men, who obviously was not so badly wounded as at first appeared, joined in the shouting and implored me not to shoot his friend who, he said, was badly wounded, and was trying to surrender. His friend certainly seemed to be doing his best to give himself up. He waved his other gun in the air and seemed to be struggling to lever himself out of the gulley without much success. I waited for some time, but despite my threats he did not move from his position. Then suddenly he scrambled out, but instead of joining his three comrades he made a rush for the top of the gulley only about twenty yards behind him. In desperation I fired the remaining rounds in my revolver at him but he only stumbled, then picked himself up and disappeared over the top.

It was galling to see what had been such a sitting bird flying away out of reach; but three in the hand was worth more than one in the bush, so I just had to let him go.

It may have been galling for me at the time, but later it was much more so for the patrols of the Gordon Highlanders who were to spend many a dreary day and night climbing mountains and searching caves for this character who they believed to be a very senior member of the EOKA hierarchy. It was humiliating to realize that so much fruitless energy was expended because of my crass inability to shoot straight.

Having watched the disappearance of number four, there was now time to have another look at the three characters lying on the bank opposite. One seemed to be in some pain, one could have been dead, and the chatty one who talked excellent English was sitting up.

I had no intention of moving as I had used up my ammunition and could only keep them covered. Equally they were in no position to take the initiative. We were all very much in the same boat and just had to wait for something to turn up.

It seemed to be an opportunity to try and discover a little of what went on in a terrorist's mind, for here was one who could talk English and there was plenty of time for conversation. After a few preliminary remarks he answered my questions quite freely. He told me his name and went on to describe how he used to work in the drawing office of the big mining company in Xeros, but had run away when the police were after him.

When I asked him why he was fighting us he just said, in a defiant sort of way, that he was fighting for his freedom against our Hitlerite and Nazi rule on the Island. He was clearly a graduate of the persistent propaganda of Athens radio, and no doubt, in his muddled mind, he believed what he said. But not unnaturally I resented his accusation, and besides, having served in Greece for some time at the end of the war, I had rather strong views about the whole situation.

So I took some trouble to try and put him right. I explained to him that it was his organization that was the stumbling block to freedom and that if they really wanted their freedom the last way they could get it was by adopting a campaign of murder and terror. I pointed out that, on the contrary, it was the British Army that was fighting to preserve freedom on the Island.

In particular I pointed out what we had done for Greece both during and after the war. How we had fought and how many had died in order to give Greece her freedom. Without our aid, I told him, Greece would have been another strangled satellite of Russia like her neighbour Bulgaria.

I had hoped to talk the man into seeing something of the folly of his ways, to sow some small seed of doubt, so that if he should escape, perhaps he would think twice before continuing his nefarious activities. But he was in no mood for further political argument, and he relapsed into a grumbling whine that I should go off to find help for himself and his friends.

So we continued to wait in silence.

We made an odd tableau, the four of us lying out there on the bare hillside, representatives of both sides in the long and bitter struggle which was tormenting the Island, powerless to do anything more than talk to each other and wonder whose friend would turn up first.

In the end, after less than half an hour, a familiar whine announced that army vehicles were coming up the road. Never has that characteristic whine sounded in more grateful ears!

The fighting patrol of the Gordons which arrived soon took charge of the situation; the casualties were taken care of and the search for the escaped men started. Soon there were Jocks on the top of every crag, but nothing was found. It was to be over a year before the escaped man was shot dead in an ambush.

The incident was over: Cyprus had claimed one more victim. Another soldier had lost his life in the service of his country; a life nurtured in a happy family, moulded in a famous school, full of promise for launching out into a chosen profession. A life full of keenness, efficiency and cheerfulness lost without purpose. For the third time the Squadron saluted with military honours at the graveside of a comrade.

Once again it was back to work, with deepened determination and resolution. At least some rough justice had been dealt out to our tormentors, and in that lay some consolation.

Other worries pressed upon us. The Troop working on Mount Olympus were faced with steadily worsening weather. Twice storms wrecked their half completed work and as winter drew on the gales and snow increased. Jimmy, their Troop Commander, had taken on a tough job and had no intention of giving it up, but I began to wonder how much longer they could keep going. They were undoubtedly the toughest, scruffiest troops on the Island by now, but they had developed such a confident superiority over hardships and setbacks that replacing them was out of the question. It was difficult to recognize them as the same greenhorns who had arrived on the Island only the month before. Other detachments had their problems too, and there was more than enough work to keep everyone busy and preoccupied.

But events which had been the private concern of the Squadron started ripples which spread out across the Island and beyond.

We knew that there was only a handful of terrorists on the Island, and that their support from the Cypriots was lukewarm and largely governed by

fear. We believed that if terrorists could be exterminated the Cyprus problem could still be solved by mutual understanding and good faith. If, as a result of actions in which the Squadron had taken part, the terrorists were nearer defeat and the hope of understanding stronger, then our losses would not have been in vain.

But events were strangling this hope. In describing our last incident the newspapers of both sides invented extravagant stories extolling their own protagonists and whipping up hatred against the other side. This was hardly likely to lead to better understanding. Again, whilst we buried our dead privately, the acknowledged terrorist who was killed in the attack was accorded a national funeral in the capital city amid demonstrations of histrionic grief. This was another blow to the hope of mutual trust.

We were only a lone little unit whose job it was to build camps and cookhouses and not indulge in politics or polemics; but it was our men who had died and I felt that we had a moral right to express our hopes.

When a summons was received to appear before a number of press correspondents this seemed an opportunity to present our viewpoint. The prospect was frightening and fraught with unknown pitfalls, but when the time came I made a straightforward appeal to the assembled company to use their power to promote understanding in place of distrust, and sympathy in place of hatred. The gesture carried no weight of authority, but it was some consolation to discover later that the sentiments expressed were received with sympathetic understanding in a great many quarters.

Now it was time to withdraw from the public eye and return to our daily tasks. Fortunately Christmas was upon us, and provided just the right excuse for a brief moment of relaxation and enjoyment after the stresses and strains of recent events. When it was all over everyone went back to work more determined than ever. The tempo of the work increased and all the time we remained alert for the next emergency—an emergency which fortunately never came.

As winter turned to spring, and the work neared completion, orders came to return to England.

We had sojourned in Cyprus for a winter, and in that time a great change had been wrought in the squadron. Our faces may have looked the same, if more weather-beaten, but in our hearts and minds the change had taken place. The flutter of insecurity, of uncertainty, of the unknown which had troubled the minds of many when they had first stepped ashore in Cyprus a little over three months before, had gone. In its place there was the confidence of achievement and the pride of success, the alertness of knowledge and the efficiency of experience. It is always a privilege to share in such a transformation, which is the hallmark of every good unit in the British Army; but it is rare that circumstances allow the change to be so swift and complete as that experienced by this field squadron of Royal Engineers.

The Taff Bridge

By Lieut.-Colonel J. M. Flint, M.B.E., R.E.

It started at a cocktail party in April when a friend of mine said that he was glad to hear that we were to build a Bailey bridge across the Taff for the British Empire Games. This was news to me, but it was not a complete surprise as we had mildly suggested something of the sort some months earlier.

I found out that a footbridge was indeed wanted, in order to get competitors and officials from their buses into Cardiff Arms Park, and would I quote for the job? Presumably the idea was that T.A. volunteers should undertake the task on one or more week-ends.

When I first looked at the site, there seemed to be no particular difficulty. It was a fair-sized gap, some 230 feet, but at that time there was very little water or current, and the river bed seemed to be firm gravel. Our first thought was towards some sort of Bailey bridge with one central pier, and in order to have an idea of its design we had to decide what was to be the likely loading. In *M.E., Volume 3*, there is a note, which proved later to be remarkably true, that people "crowded together in a disorganized mass, unarmed" can cause a live loading of 175 lbs. sq. ft. We did some calculations on this basis and found that, if extra widened Bailey were used, at least double-single construction would be needed, and that the dead weight of equipment and stores would be at least seventy-five tons. This dead weight was a material factor in the estimate, since I had ascertained that the Command Secretary would set the transport costs at about £10 per ton whatever the distance. It was clear therefore that the cost of building a Bailey bridge, even with no labour charges, would run well into four figures. This was too much for the Empire Games Committee to contemplate.

The next step was to do a more detailed reconnaissance of the gap. On this occasion too there was very little water, even at high tide. As a result I came to the conclusion that the only feasible solution was a tubular scaffolding bridge. I put this proposal to the Games Committee, and was rash enough to quote a figure of £400 for the job. I made the point that we could not do the job with T.A. volunteers alone, but that a small regular detachment would have to be provided.

I would not have been surprised if that had been the end of the matter, but in fact the Games Committee accepted the quotation with alacrity, and through the efforts of the local Brigade Commander a troop of the Parachute Squadron R.E. was allotted the job. The matter was also cleared with the appropriate trade union. It looked as if the job was on.

It was not until the City Surveyor heard about the idea and told us his views, that we began to realize that the river was not always as mild as it sometimes looked. It was eventually established that the tidal range during spring tide periods was as much as ten feet. On top of this I was assured that floodwater could raise the level another two feet and cause a current of four to six ft./sec. There were also the problems of the unstable river bed and of heavy debris such as tree trunks which had been known to sail down the Taff. In fact these very conditions did materialize after a period of heavy rain in early June.

These gloomy forebodings led us to examine the whole problem afresh and this time we prepared a written appreciation. What emerged from this was that a suspension bridge was quite a possibility. The main difficulty was to fit in the anchorages. We did a good deal of theoretical work on this, but by now it was only four weeks from the date on which the work had to start and we had not yet put in the stores demand. This, together with the picture of an increasing cost of stores movement, led us to abandon what might have been a more impressive looking job in favour of the tubular scaffolding bridge.

It was interesting that, out of the two well-known suppliers of tubular scaffolding whom I approached, one said that the job was not a practical proposition in view of the water hazards and the other said that it could be done without undue difficulty. The latter did a rough estimate of quantities and their quotation for hiring the equipment from their Cardiff depot seemed to be very reasonable.

By this time the Regimental permanent staff would have been very hard pressed if help had not been forthcoming from outside, in the shape of an officer from C.R.E. Works and a Sapper draughtsman/quantity surveyor. These two spent a busy two weeks producing drawings and laying on the supply of stores and equipment from various sources. Local firms were most co-operative in helping to reduce the cost of stores. The design of the bridge as it emerged at that time was based on a continuous through truss over two piers giving three unsupported spans of 40 ft. each. These looked all right on paper but none of us really knew how rigid they would be and how the problem of the joints could be overcome. The general arrangement is shown in Fig. 1. (Folding Plate.) Between pp. 39 and 40.

It was during this period that 9 Parachute Squadron were posted abroad leaving us temporarily without a party to build the bridge, except of course all four of my own permanent staff drivers.

These men did a useful job the following week building two trial piers linked with one of the 40 ft. spans. This was done at the T.A. Centre and undoubtedly was worth the effort. Apart from learning a number of practical snags we were able to give the span a trial loading to test its rigidity. This we did by putting twenty-five men in the central 10-ft. of the span and getting them to stamp up and down. Apart from one nasty groan from one of the couplers, the structure seemed to be little affected by this, and the deflection of the span was very slight. The couplers incidentally were all three piece, with chair, with a safe loading of 25 cwt., and no swivel couplers were used. All joints in the top and bottom chords were butt jointed with spigot couplers and lapped with 2 ft. of tube with four couplers.

While the practice span was being built we were still checking various points of the design. The safe loading which we hoped to achieve was three people side by side every 1 ft. 6 in. of bridge plus an impact factor of 50 per cent. This came to 480 lbs./ft. run. The factor of safety, bearing in mind that this was to be a temporary bridge, had to be at least 2.

In working out whether this loading was a practicable proposition or not, I considered that there were four limiting factors:—

(*a*) the strength of the compression members, and particularly those marked A in Fig. 1;

(*b*) the safe loading of the couplers;

(*c*) the strength of the bottom chords, the road bearers, in bending;

and (*d*) the protection of the piers from the impact of debris. Of these it seemed that (*a*) was the most serious, and it became even more so when we discovered that the tube actually being used was lighter than that on which our earlier calculations had been based. This of course was a snag which never should have arisen, but it did cause some worry and lead us to take some expert advice. As a result of this it was decided to double the diagonal struts on each span, and their couplers, and to incorporate some additional bracing.

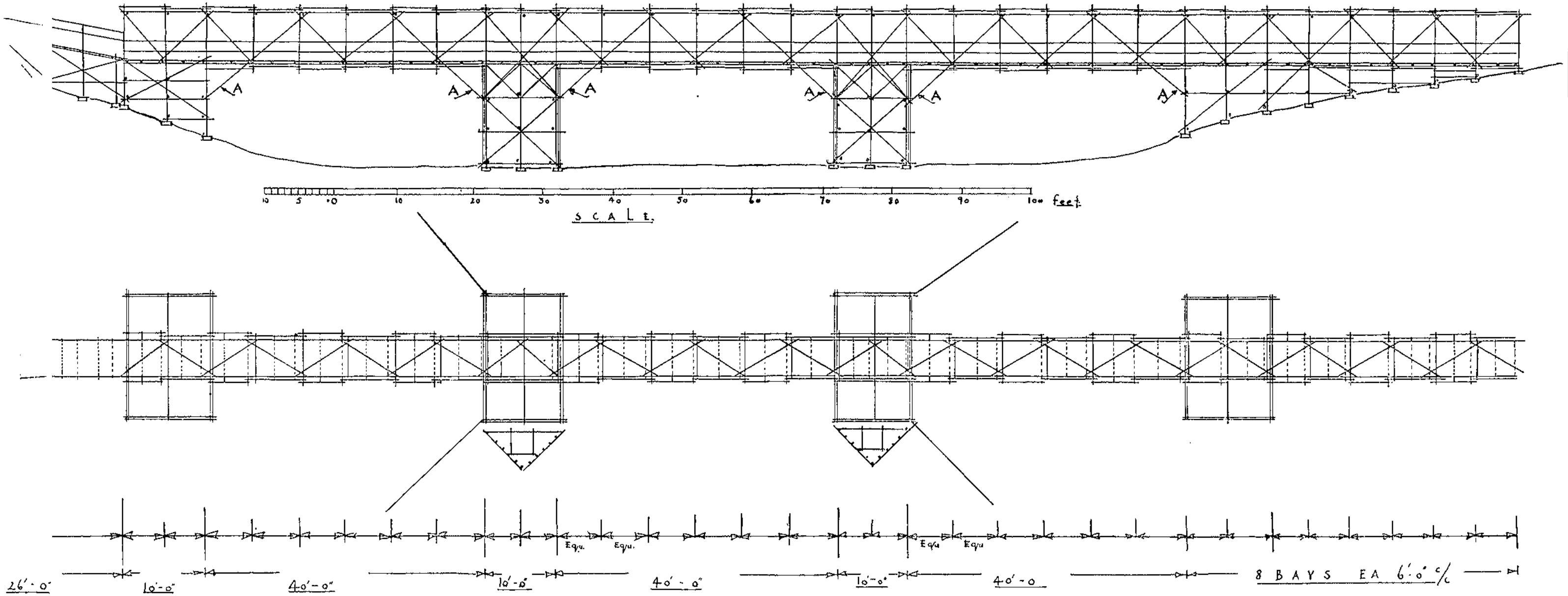
At last, having made the modifications, I was reasonably satisfied that the desired safe loading could be accomplished and the written engineer project was issued.

This in layout was a somewhat abbreviated version of the form given in *M.E., Volume 1*. It included the stores schedule, work programme, site plan, and working drawings. It also included the tide forecast, and an important and controversial document, the estimate of costs. One wondered at the time whether all this paper was really necessary, but it did mean that the various civilian authorities received the information in a comprehensive form. I was also well aware that the officer in charge of the work and the working party had not yet been detailed and it was therefore necessary to have all the relevant information available for him in a convenient and easily digestable form. On balance the written project was worth the trouble involved.

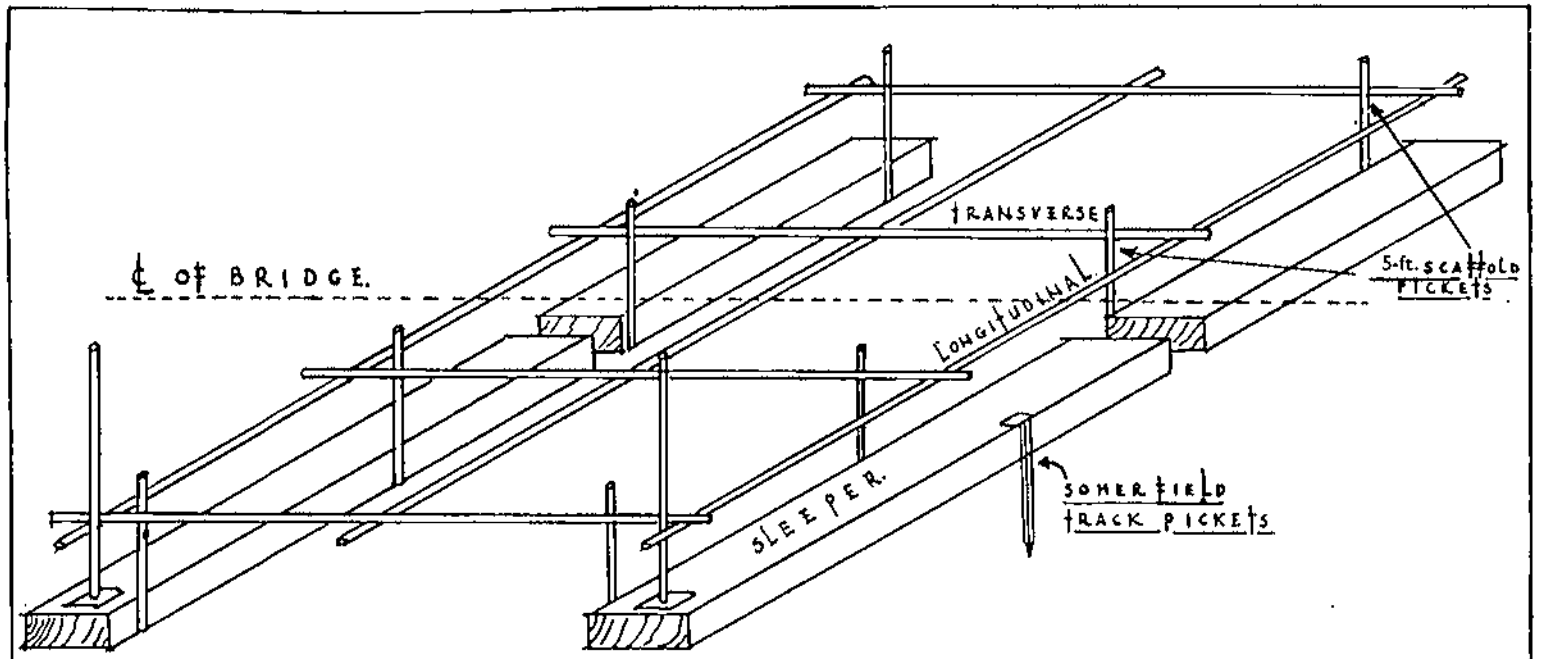
The working party materialized on the day before the task was due to start, when an officer and thirteen other ranks of 50 Field Squadron arrived in Cardiff. No previous reconnaissance had been made and they had little idea as to what the job was. But the situation was not as difficult as it sounds. Continuity between the planning and the execution was provided by the officer attached from C.R.E. Works, who now became the officer in charge of the work. One of the Regimental permanent staff instructors who had been associated with the project from the outset was also available. Special mention must also be made of the four permanent staff drivers, who had proved themselves as adaptable as ever in the trial build, and were now to reinforce the building party.

The work started promptly and the combined working party soon got into the swing of it. Building started from the street end where we had direct access to the site. All stores were kept on lorries, in order to avoid the problem of guarding loose stores at night and incidentally to avoid blocking the road unduly. The permanent staff drivers drove the lorries to the site each day and then became scaffolders. The sapper quantity surveyor was charged with recording the stores used from the various sources. The principle, in building each span, was to divide the party, one to build the span on temporary supports, and the other to build the pier to receive the span.

During the building the greatest care was taken to line up all vertical members accurately, bearing in mind that any error early on could have dire consequences later. The most intricate part of the operation was the placing of the pier bases, which are shown in detail in Fig. 2. The sleepers, on which the vertical standards rested on base plates, were to be spiked into the river bed. Clamped to the transverse members were 5 ft. scaffold pickets, ordinary lengths of tube, which it was intended to drive 2 ft. 6 in. into the river bed. The problem was how to drive the scaffold pickets accurately and without upsetting the alignment of the standards. The drill evolved was to construct accurately the frame of horizontal members and to attach to these the scaffold



1 July 58.	GENERAL OUTLINE OF BRIDGE	FIG. 1
auman L.I.O.B.		



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THE BASE TEMPLATE IN POSITION.

FIG. 2.

Photo 1.—Placing one of the pier bases.

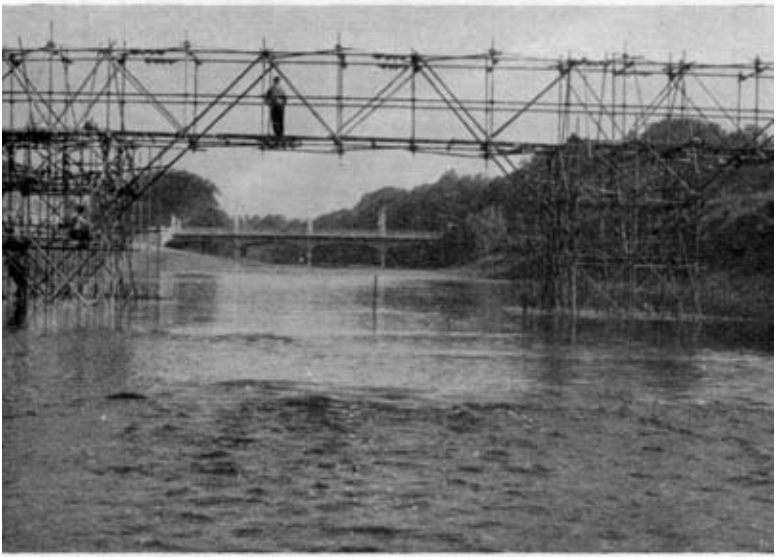

Photo 2.—Central span, before decking down.

The Taff Bridge 1,2

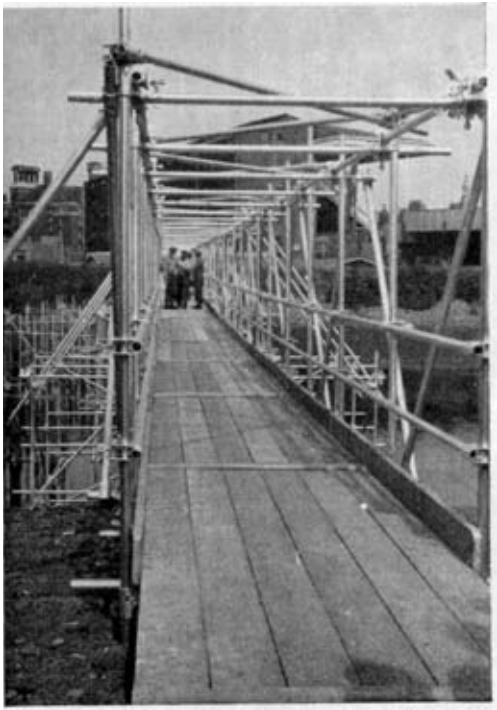

Photo 4.—View from end of bridge, looking towards Cardiff Arms Park.

Photo 3.—Work in progress on home bank, showing doubled diagonal struts

The Taff Bridge 3,4

pickets. The frame was carried bodily into the water and placed accurately in position. The standards were then placed in position one at a time, coupled to the frame, and sleepers and base plates inserted underneath them, again one at a time. Little or no trouble was caused by the buoyancy of the sleepers. When all main standards were in position and properly aligned, the couplers attaching the scaffold pickets and standards to the frame were loosened off and the scaffold pickets driven into the river bed with a drivall. When this had been done the whole frame was lowered to as near as possible above the sleepers and the couplers tightened. Finally the sleepers were spiked to the river bed with the aid of a special extension which had been made to drive the pickets under water. The whole process worked well and no trouble was experienced with alignment of the piers. This was due in no small measure to the careful preparation of the drill on dry land beforehand. We were also greatly helped by the dry weather which gave shallow water at low tide.

The spans were built on temporary supports resting on the river bed. Here the problem was one of vertical alignment. It was intended to introduce a rise of two to three inches at mid span. In the second and third spans this was achieved and they looked well. The first span, however, gave trouble from the start, partly because it was the first attempt and partly on account of settlement. It had to be straightened, using ordinary MT jacks, after being built. The result looked all right, but was not perfectly straight. It might have been better to have rebuilt this span, as soon as any deviation from alignment appeared.

The actual construction of 230 ft. of bridge, involving 8,000 ft. of tube, took fifteen men eight working days and during the mid week-end a T.A. detachment took over the job. Thereafter the bridge was painted with aluminium paint, decked down and the trimmings fitted including an ornamental archway adorned with a Welsh dragon.

For the protection of each pier against floating debris tubular scaffolding dolphins were built just upstream and spiked into the river bed. There was also a steel wire rope standing cable further upstream to enable a folding boat to give access to the dolphins at all states of the tide, so that any accumulated debris could be cleared.

The bridge was officially opened by the Lord Lieutenant of Glamorgan four days before the opening of the Games. It looked remarkably tidy, and it felt robust. One expert's estimate was that it would take a load of 12 tons on each span. This was about 50 per cent more than 480 lb./ft. run for which the bridge was designed. This estimate proved to be a true one, as events showed rather sooner than I had anticipated.

It occurred after the opening ceremony when a large crowd of competitors and officials began to use the bridge. The police had not been properly briefed on the need to keep people moving, and indeed the number of small autograph hunters made their task almost impossible. The exit of the bridge soon became completely packed with people. All would have been well had not some of the more hearty athletes started to jump violently up and down and to swing on the overhead bracing. The bridge put up with this maltreatment for several minutes, but suddenly there was a loud report and the home span dropped about three inches. After that the bridge was cleared fairly quickly.

The damage in fact was not serious. One coupler had sprung and several others had slipped slightly. The following day the span was jacked up, the

couplers re-positioned and the whole span trued up. This was the second time that we had trued up this particular span, and no doubt the previous straightening had caused uneven loading, which in turn caused the coupler to spring when the bridge became overloaded. The other essential measure which was taken the following day was to put up crush barriers, with the approval of the police, to prevent the exit becoming blocked again. This measure proved to be fully justified on the closing day, when many hundreds of people crossed the bridge in a short time.

Dismantling the bridge took three days. This was the only period in which there was heavy and prolonged rain, which caused a strong current and an abnormally high water level. Even at low water the depth was over four feet, and with the strong current it was found impossible to dismantle the pier bases. This clearly demonstrated the difficulties of working in over two feet of water, and showed how fortunate we had been in the construction period.

On a project of this kind a number of lessons were learnt. Some of these are of special application, but the following points are, I think, of general interest:—

(*a*) When bridging a water obstacle it is important to discover early its characteristics. In this case it took some time to collect and evaluate the information and the various opinions offered. Once that had been done, it was possible to assess the risks involved.

(*b*) Careful planning, both on the drawing board and on a practice site, pays big dividends. In particular it is well worth while practising a difficult drill, such as the placing of the pier bases, on dry land beforehand.

(*c*) For a footbridge which may be used by large crowds it is essential to make a realistic estimate of the loading and to plan for all eventualities. Proper control of crowds at the entrance and exit of the bridge is essential.

The cost of the bridge proved to be very near the original quotation, and it was generally acknowledged to have been good value for the money. It was also excellent training value for all those concerned, and a good advertisement for the Sappers and the Territorials.

Prefabricated Buildings

By MAJOR F. W. L. SHEPARD, M.B.E., R.E.

INTRODUCTION

THE aim of this article is to describe the development of prefabricated buildings and to discuss their characteristics. Some of the most interesting current systems are illustrated, and an attempt is made to forecast future developments.

Military applications are considered with reference to both war-time and peace-time requirements. A description of the new range of service hutting is also included.

A great deal of material has been published on this subject, but the rapid developments of the past ten years have made much of this out of date.

Appendix "A" contains a list of recent publications and also enumerates the British sources from which further information can be obtained.

The Characteristics of Prefabrication

Definition. "Prefabrication" means literally "making beforehand", and nearly every building contains a number of components made in this way.

Several different definitions are now current, but for the purposes of this paper a prefabricated building is one designed to make the maximum use of manufacturing processes.

These processes may be applied to the mass-production of units in a factory, or to the pre-forming of components on site. Their object is to make the most efficient use of materials and to reduce erection labour to a minimum.

Other modern techniques such as "vacuum" concrete and storey height shuttering are excluded because they are essentially *in-situ* processes and are therefore outside the scope of this article.

Methods of Approach. Such a wide variety of systems are now in existence that it is difficult to classify them simply. Most methods, however, fall into one of the following categories:—

(*a*) *Specialized Units.* These are usually designed for a single type of building or limited range of buildings only, and they cannot be used for different structures without extensive modification.

In some cases the unit of production is a complete house, and a large number of different individual components may be involved.

In general such a system can only be economically applied when a large number of similar buildings is required.

(*b*) *Standard Parts.* Such components are intended for use in many different types of structure and may be distributed wholesale to building firms. Typical examples are the standard doors, windows and cladding sheets used throughout the industry.

Only simple structures can be made up entirely from these parts, but they are often combined with specialized units.

(*c*) *Modular Units.* A "module" is a standard unit of length used for expressing architectural proportions. "Modular Co-ordination", originally used to ensure well proportioned buildings, now implies the use of parts with standard dimensions that can be assembled in a variety of combinations.

By applying this principle it is possible to produce many different designs from a relatively small number of standard components.

In England the Modular Society has been formed to encourage standardization, and the firms belonging to it co-operate in working to a basic 4-in. module.

This means that the principle dimensions of all structural components are multiples of 4 in. For example, one firm's standard wall panel is 3 ft. 4 in. wide by 8 ft. high. Door and window frames are similarly standardized, and a wide range of buildings can be assembled from these parts.

(*d*) *Composite Systems.* Any or all of these methods may be combined with *in-situ* construction, and few buildings are at present completely prefabricated. A typical compromise is the Schindler-Goehner System developed in France, in which the inner wall linings, partitions and services are prefabricated, but the external cladding is in brickwork or other traditional material.

Methods of Construction

Prefabricated structures are governed by the same constructional principles that apply to traditional buildings, but the types of structure indicated are those best suited to prefabrication.

(*a*) *Framed Structures.* In this case the panels are usually large prefabricated units, often of storey height. Being non load-bearing they can be made up of thin sheets of material separated by an air-space, which may be filled with light-weight thermal insulation.

The framework often consists of pre-cut members connected on site, but in concrete construction the panels are sometimes used as formwork for an *in-situ* frame.

(*b*) *Load-bearing Panels.* Here also the panels are often storey-height units, but they require rigid connexions that present difficulties in design.

In some systems the panels are combined with a framework whose main function is to simplify the joints and to provide structural continuity.

(*c*) *Stressed Skin Structures.* In this type of structure the whole fabric of the building is bonded together in one monolithic unit. Properly applied, the principle ensures maximum structural economy by making every part take its appropriate share of the load.

The main difficulty is again the design of site connexions, and so far only one British experimental system makes full use of it. This example is made up of double-skinned plywood panels bonded together on site with cold-setting resin glue.

Several successful American designs do, however, employ plywood panels that are in effect individual stressed skin units.

(*d*) *Space Frames.* These are three-dimensional lattice structures assembled from standard struts and ties. An example is given in Appendix F. Although it is mainly applicable to large span roof structures, this principle can also be used in floors and columns. Bridges are an interesting additional possibility.

Materials

Most standard building materials are to some extent amenable to prefabrication, but the following possess characteristics that make them particularly suitable.

(*a*) *Timber.* Possibly the oldest building material, but still widely used in the newest forms of construction. Easily shaped by machine tools, and in laminated or reconstituted forms can be produced in large panels.

Seasoning is essential for accurate manufacture, but modern artificial ageing processes have greatly reduced the time required.

(*b*) *Steel.* Sometimes referred to as a "precious" metal in building, and traditionally reserved for parts requiring special strength and durability.

Apart from simple drilling, welding and cutting operations its manipulation requires heavy machinery. For this reason most steel components are shop fabricated and site working is reduced to a minimum. These considerations also apply largely to the other metals employed in building, and in particular to the aluminium alloys now widely used for cladding and light structural members.

(*c*) *Concrete.* This is a material that in many ways seems unsuited to prefabrication. It is difficult to bond after casting and does not lend itself readily to "dry" jointing. It is also heavy, bulky and difficult to transport without damage.

However, shuttering is expensive and much can be saved by repetitive pre-casting, while the exact dimensions and careful control required for pre-stressed and other high grade work are more easily obtained under factory conditions.

Also, since normal concrete has poor insulating properties, special treatments such as cavity construction are often required and these are difficult to carry out *in-situ*.

It is undoubtedly the case that a high proportion of all concrete used in building is at present pre-cast, either on the site or in the factory.

(*d*) *Plastics*. The building applications of those materials are still in their infancy owing to the high cost of most products. At present only a few British firms are manufacturing structural components, but the chemical industry is carrying out extensive research and new processes are continually being developed.

Plastics are divided by their physical properties into the "thermoplastic" and "thermosetting" groups. The former soften when heated, usually below 200°F., the latter set when first heated and will subsequently stand temperatures of up to 650°F. without damage.

Both groups are used in prefabricated buildings, although thermoplastics are too unstable for structural components. Thermosetting plastics lack ductility when used alone but when laminated with other materials can attain an ultimate tensile strength of up to twenty tons per square inch for only one-quarter the specific gravity of steel.

Plastics can be cast, moulded, pressed, extruded or rolled into almost any shape required for building.

Fairly elaborate machinery is required for all of these processes, and thermosetting materials need careful curing at controlled temperatures.

For these reasons plastic products are of course factory made, and site work is confined to simple cutting, drilling and fixing operations.

Quantity Production

Design for production is the key to successful prefabrication. Economy can only be achieved if units are simple and easy to manufacture.

Production processes must also be geared to the quantities required, and the high capital cost of mechanized equipment has to be justified by a correspondingly large output.

Prefabrication facilities may range from a small part of the site set aside for pre-casting to a great factory equipped with automatic machinery. Certain materials such as pressed steel can, however, be worked only by heavy equipment, and any system using these involves a big initial outlay. Unless an adequate market is quickly found, such a system is likely to fail, however ingenious and efficient it may be.

For this reason careful research and development is essential before large-scale production begins, and radically new designs can only be introduced if they are backed by a large firm or government undertaking.

Once production is under way there is a tendency for design to stagnate owing to the vested interest in factory equipment. If, however, the factory has been skilfully planned it will be possible to modify its equipment to meet new demands when they arise. In general the most successful systems are those most capable of adaption to changing requirements.

Quality

Since mass-produced building components must be simple and economical if they are to succeed commercially many firms concentrate on low cost buildings.

These are generally light structures such as temporary huts, sheds and bungalows, which satisfy a large market but which tend to bring prefabricated buildings into disrepute among the general public.

In fact buildings of the highest quality can be successfully prefabricated, as has been shown by the new schools recently built in this country. If suitable materials are used it is possible to obtain a more regular and durable finish with factory made units than can be got with bricks or plaster.

In addition to its savings in bulk, weight and cost a good prefabricated wall panel has greater thermal insulation and moisture resisting properties than a standard cavity wall.

When very thin panels are used, particularly those with metal sheathing, it is necessary to guard against condensation. This can be done very simply by either sealing or ventilating cavities and by providing a continuous vapour barrier of building paper or similar material.

Acoustic absorption is also a problem in light panels, and in some cases these have to be filled with sand or similar material to provide the necessary weight.

It is usually a simple matter to provide built-in pipes and wiring for the various services, since ducts and outlets can be incorporated during manufacture.

As far as architectural design is concerned, appearance is a matter of taste and there is no reason why a prefabricated structure should not be as pleasing in its own way as a traditional building.

Limitations

Prefabrication is not the answer to every building problem. There will always be occasions when manufacturing facilities are uneconomical or not available. There are other new building techniques for simplifying and mechanizing *in-situ* work which have their own particular spheres of application. Each project should be considered on its merits and carried out in the way best suited to the particular set of factors involved.

At first sight it would seem that single buildings of individual design are unsuitable for prefabrication. There are, however, so many important exceptions, of which the United Nations Secretariat is sufficient example, that no generalization can safely be made.

On the other hand, when a large number of similar buildings are required prefabrication is not necessarily the best approach. A notable case in point is the new Indian city of Chandigarh, where cheap local labour and materials make the old methods the best.

Historical

> "*And the house, when it was in building, was built of stone made ready before it was brought thither; so that there was neither hammer nor axe nor any tool of iron heard in the house, while it was in building.*"
>
> *I Kings, vi.*

The Beginning. Solomon's temple is by no means the first instance of prefabrication, which in its wider sense is almost as old as building.

The tent was probably one of the earliest forms of man-made shelter, and it remains as the simplest prefabricated structure without any signs of obsolescence.

One recently developed large-span storage building does in fact use the same structural principles as a ridge tent. The roof cladding is supported on cables strung from a central horizontal member.

Bricks and tiles are obvious examples of components made away from the site on a series production basis, but they are now giving way to larger factory made units that do not require skilled craftsmen to erect them.

Pre-cut timber has also been used in building for many hundreds of years, and it is reported that the settlers in the *Mayflower* carried with them the framework of two timber houses ready for erection in the New World. British prefabricated houses are still exported all over the world for assembly by unskilled labour in undeveloped countries.

The Nineteenth Century. The Industrial Revolution in England brought with it the development of factory processes and the beginnings of mass production.

During this period cast iron came to be extensively used for the structural frames of buildings, and perhaps the most celebrated example was the Crystal Palace, designed by Joseph Paxton for the Great Exhibition of 1851.

This was constructed entirely of factory-made repetitive units and was erected in less than six months. It was also dismantled and re-erected at Sydenham without difficulty.

In both Europe and America abundant supplies of cheap softwood favoured the production of sectional timber buildings, which were manufactured in increasing numbers from 1850 onwards.

In the American Civil War the Union Army was housed in prefabricated timber barracks—possibly the first military use of this type of building.

The Twentieth Century. The First World War brought demands for great numbers of rapidly erected temporary buildings of all types, and many prefabricated designs were produced.

Outstanding among these was the Nissen hut, still widely used and practically unbeaten in this country for low cost coverage.

Its structural economy is due to the use of a stressed skin which permits a very light framework.

In the post-war period, Great Britain was faced with an urgent need for houses, coupled with a shortage of bricklayers and other skilled labour.

These factors led to the introduction of many schemes for new types of building, including some partially prefabricated systems based on steel or concrete frames.

Several thousands of each type were built, but these "unconventional" systems were generally regarded as only temporary substitutes for "traditional" building methods. Little was done to adopt architectural styles to the new techniques and drab, uninteresting houses resulted.

Largely for this reason most of the prefabricated systems were abandoned in the later 1920's when labour conditions returned to normal.

In America between the wars there was little large-scale production of prefabricated buildings, but many experimental systems were tried out,

including designs in timber, concrete, steel, gypsum and various composite materials.

The American skyscrapers, although until recently clad with conventional materials, made use from the outset of factory processes to produce standard parts for their steel frames.

German researches into prefabrication were also extensive during this period. Particularly attention was paid to production and handling processes, and in most cases the numbers of buildings erected did not justify the high capital cost of the equipment. These processes are, however, essential to successful prefabrication and the techniques perfected then have been partly responsible for Germany's rapid recovery after the two world wars.

During the 1939–45 war a great number of different hutting systems were used, but there were few really notable new designs.

One exception was the "South West Pacific" hangar with an arched roof of 130 ft. span made up of 12-ft. sections weighing only 220 lb.

In the U.S. extensive use was made of timber in order to conserve steel, and in addition to the framed and boarded construction already developed several plywood systems were put into production. Among these were some early examples of monolithic stressed skin buildings bonded with resin glues.

In the later stages of the war "prefabs" were manufactured in Britain in large numbers to house bombed-out families. Each firm adopted a standard design, in which ease of production was a primary consideration.

The maximum amount of construction was done in the factory, and the size of the sections was limited only by transportability. Many ingenious features were included, such as prefabricated plumbing and electrical services.

Current Systems

Great Britain. The war-time prefabricated houses did good service in providing much-needed temporary accommodation at a rate that would have been unattainable with traditional building methods.

Unfortunately, these efficient but ugly buildings made the name "prefab" synonymous in the public mind with sub-standard dwellings.

This impression still lingers, and the most successful current prefabricated houses are usually those which bear the closest superficial resemblance to traditional buildings.

Only seven British firms now prefabricate permanent dwelling houses, and two of these deal mainly in timber bungalows. The remainder generally employ concrete wall panels with a steel or reinforced concrete frame.

The application of the new methods provides a challenge to architects that has been met with varying success, but the best samples of contemporary design are in no way inferior to their predecessors.

Many of the new schools built for the Ministry of Education have ably demonstrated the possibilities of applying prefabrication to high-class work.

Industrial buildings are unfettered by tradition, and efficiency coupled with economy is the basis of their design. Most factories and warehouses are therefore made up of light frames of steel or reinforced concrete clad with sheets of asbestos or aluminium and lined with insulation board when necessary.

The framework is almost always prefabricated for reasons of economy and accuracy.

The size of the cladding sheets is usually limited so that they can conveniently be fixed by hand, but larger units are coming into use for glazing and partitions.

Lightweight steel framed buildings have been exported in large numbers to Commonwealth and other countries for low cost housing, labour camps and the new oil towns in the Middle East. Probably the largest exporter is the Arcon group, which pools the resources of five firms to obtain maximum production efficiency.

A very large part of the British prefabrication industry is devoted to small buildings such as garages, greenhouses, farm buildings and stores sheds. Economy is the ruling factor here and there have been few fundamental changes in designs during the last twenty-five years. Increasing use is, however, being made of industrial manufacturing methods including assembly lines and automatically controlled machinery.

The same considerations apply to the present temporary buildings, many of which were designed for hutted camps during the First World War.

There have, however, been important developments in the field of "demountable" buildings that can be dismantled and re-erected rapidly and without damage. These have obvious advantages for military purposes and the new range of army hutting described in Appendix "B" employs an ingenious screwless cladding system.

This class also includes folding buildings such as the "Terrapin" used by some contractors for site offices and various trailers and caravans which do not require prepared foundations.

Finally, there are some alternatives to the traditional tent. One of these has an inflatable frame of plastic material and can provide sleeping accommodation for up to thirty men with a weight of only 160 lb. Another is made up of small interlocking aluminium sections which can be transported on camels (or by air). A rather special model has been exported to Arabia to provide the world's first prefabricated palace for King Ibn Saud.

U.S.A. Skyscrapers are the most striking form of American building, and from their inception they have been based on steel frames made from members rolled, cut and drilled in factories. Recently new cladding materials have been introduced, including aluminium, glass and stove enamelled steel. These are manufactured in large panels in which the windows are usually incorporated, and it is now common for almost the entire building shell to be made up of only two or three different types of panel.

The economy of this method of manufacture is obvious, and additional advantages include light weight, rapid erection, striking appearance and easy maintenance. Internally, prefabricated partitions are made demountable so that layout arrangements can be varied as required. Floors and ceilings incorporate panel heating, and electric points are provided at close intervals.

Prefabricated bungalows are manufactured in large numbers and several factories are now producing complete houses packaged ready for assembly on prepared foundations.

The necessary variety is achieved by providing a range of varying layouts and finishes to suit individual requirements. The factories are all highly mechanized with conveyor systems, automatic shaping machinery and production-line assembly of components.

Experiments with new methods and materials continue; there is an in-

creasing use of plastics for structural components, while stressed plywood units bonded with phenolic glues are superseding the old framed and boarded panels.

Germany. The housing problem caused by the devastation of the last war assumed gigantic proportions, but it has been mastered by German thoroughness and diligence.

Early post-war research in Western Germany showed that the enormous quantities of rubble available made suitable aggregate for mass concrete, and multi-storey buildings were designed in this medium. To provide insulation, the buildings are faced with pre-cast blocks of a porous lime-concrete material called Ytong. This has been produced in Sweden since 1929, and among other advantages its amenability to sawing and drilling make it easy to fabricate and to erect.

Ytong is also extensively used in load-bearing blocks for walls and partitions.

Another widely used technique employs pre-cast panels of air entrained concrete. These panels are generally load-bearing, but reinforced concrete frames are used for buildings of over three storeys. Pre-cast air entrained concrete is also used for floors, roofs and partitions, sometimes in conjunction with steel or timber frames.

Perhaps the most striking German contribution to prefabrication has been in the field of erection technique.

Modern plant includes tower cranes, of which over 3,000 are now in use; mobile cranes of many types; derricks and gantry cranes mounted on rails. The last have been made large enough to bestride a ten-storey building, and are particularly effective for the rapid placing of large prefabricated units in blocks of flats. Smaller gantries are also used extensively in the curing yards of pre-casting factories.

U.S.S.R. Russia has been struggling with a housing problem possibly larger than Germany's, and in recent years increasing use has been made of prefabrication for flats, houses and industrial buildings.

Many factories have been built to produce building components in concrete, timber and steel. Some of these are reported to be automatically controlled.

Extensive use is being made of large pre-cast reinforced concrete panels in which insulation is provided by cavity construction and the use of furnace slag aggregate.

A new air-entrained aggregate called Keramzit is made by the rapid firing of fusible clays. It is claimed that this is strong enough for large load-bearing panels, and can be reinforced in the same way as normal concrete.

Erection equipment used for tall buildings includes giant climbing cranes which can lift themselves storey by storey as construction proceeds.

France. The volume of prefabricated production in France has always been small by comparison with the other countries listed, but many important new ideas have originated there.

Pre-stressed concrete is one of these, and several notable pre-cast structures in this medium have been built. High cost is at present a disadvantage, but this may vanish as manufacturing techniques improve.

Recent experiments include an all plastics house and a ready-made *bloc sanitaire* incorporating cooker, heater, sink, shower, wash basin and W.C.

Sweden. This country continues to be one of the world's largest producers of timber buildings. There have been few significant changes in design, but new insulating materials such as fibreglass are increasingly used.

Of particular interest is a "do it yourself" scheme sponsored by local authorities in which the building owner buys ready-made parts designed to be assembled without skilled labour.

Other developments include the Ytong mentioned under Germany, and various systems employing pre-cast concrete panels.

Other Countries. Prefabricated buildings have also been designed and erected in Australia, Canada, Czecoslovakia, Denmark, Holland, Hungary, India, Italy, Norway, Poland, Roumania, Spain, and Yugoslavia.

There has so far been little large scale production in these countries, but many notable individual projects have been carried out.

Future Developments

Basic Trends. Some theorists hold that manufactured buildings will eventually supersede traditional houses in all civilized countries. They foresee an entirely new type of dwelling; transportable, variable in layout, and self-contained with its own supply of nuclear power.

Others envisage a whole community housed in one vast apartment block containing facilities for shopping, education and recreation.

These ideals relate to the distant future and are outside the scope of this paper. Certain trends are, however, discernable at the present time.

Manufactured articles of all kinds are being produced more by machines and less by hand. The skill of the craftsman is being replaced by the precision of the machine tool.

Building components are not exceptions to this trend and already in America there is a striking similarity between the production and marketing of houses and cars. From Russia come reports of automation in pre-casting factories and it is already common for concreting machinery to be electronically controlled.

It is clear that this industrial evolution will continue, and that all building processes will eventually be mechanized where this can be done efficiently and economically. On the other hand there will always be occasions when work is best done *in-situ*, and certain parts of buildings that have to be adapted to each individual site do not generally lend themselves to prefabrication.

Some of the newest building techniques are in fact *in-situ* processes and it seems likely that they will continue to compete with prefabrication.

New Materials. As far as materials are concerned there is little doubt that plastics will be very widely used in building as soon as the cost of their production can be brought down. As an example of what can already be done, a standard hollow plastic panel $1\frac{5}{8}$ in. thick filled with glass fibre will provide a satisfactory external wall without further insulation or finish.

The use of plastics in conjunction with timber laminates, plywoods and compositions also offers a promising field for development in those countries where timber is cheap and plentiful.

Aluminium and other light alloys are at present in vogue, but it seems unlikely that they will ever replace steel in the framework of large buildings. The use of these and other metals is largely governed by availability and radical new developments seem unlikely except in the field of non-corrosive finishes such as vitreous enamels and anodized surfaces.

Concrete is firmly established as a major building material and will clearly remain so for a long time to come, but its lack of tensile strength may eventually lead to its losing ground in favour of plastics unless a suitable binder can be found.

Methods. New constructional systems are difficult to forecast except where their experimental beginnings have already been made. Two promising lines of development are the space frame, which is a three-dimensioned structure built up of small interlocking prefabricated units, and the monolithic stressed skin building in which loads are shared by the whole fabric.

At present it seems that the space frame as illustrated in Appendix "F" is best suited to large span buildings such as factories, while stressed skin construction is theoretically ideal for the small dwelling house.

Both these methods are combined in the ingenious Geodesic domes developed in America by R. B. Fuller.

These domes, which can be rapidly erected over large spans, are made up from identical small units interlocking on a spherical surface.

They illustrate the simplicity and economy to be expected in future prefabricated buildings.

Military Applications

Classification. Military building requirements may conveniently be divided into temporary or war-time structures, and permanent or peace-time barracks and installations. The basic needs for accommodation are similar in each class, and many temporary buildings are in fact converted to peace-time use.

Temporary Buildings. The principal war-time requirements of a mechanized army are listed below:—

Description	*Span* ft.	*Clear Height* ft.
Blast proof shelters	6– 20	6–10
Living huts	16– 20	7– 9
Cookhouses and dining halls	16– 30	9–12
Latrines and ablutions	10– 20	7– 9
Offices and laboratories	20– 25	7– 9
Hospitals	24– 30	7– 9
Stores	15– 50	10–20
Workshops	20– 50	15–30
Hangars	50–200	20–50

All the above structures, and various other specialist buildings such as cold stores, have to be capable of rapid erection by unskilled labour.

It is clear that these requirements can only be met by prefabrication, except when labour and local materials are sufficiently plentiful for the construction of simple buildings of the "basha" type.

Prefabricated buildings intended for use in war require the following particular characteristics:—

(*a*) *Availability of Materials.* Certain materials such as aluminium are likely to be in short supply during a major war. Unless building components can be stockpiled beforehand these materials should obviously be avoided, and if they must be used, alternatives should be found.

(*b*) *Production Capacity.* Components must be suitable for very large-scale production by several different firms and standard commercially available products should be used whenever possible.

(*c*) *Erection.* Site work should be limited to simple manual operations such as bolting or nailing. Parts should be light enough for erection without mechanical lifting equipment.

(*d*) *Demountability.* A building that can easily be taken down and used again has particular advantages in military use. It can be made more durable and to higher standards than a "once only" structure without sacrificing economy, and in many cases it may be suitable for permanent accommodation.

(*e*) *Transport.* Army hutting may have to be carried by sea, road, rail or air. Units must therefore be compact, light and able to stand up to rough handling.

"Nesting" components such as corrugated sheets are an advantage but small parts like nuts and bolts are apt to get lost and need special packing.

(*f*) *Adaptability.* The British army specify an "operational" temperature range from — 25°F. to + 125°F. This involves a snow loading of 20 lb. per sq. ft. and a wind velocity of up to 80 m.p.h.

Fly-proofing, dust-proofing and air conditioning may be required in hot climates. Provision for blackout will be necessary, and external finishes must be suitable for camouflage. It should be possible to use improvised cladding made from local materials.

The design must be sufficiently flexible to deal with the wide variety of spans and layouts necessary for the requirements listed at the beginning of this chapter.

(*g*) *Foundations.* Since buildings may have to be erected on widely differing sites, prepared foundations should be reduced to a minimum; the ideal design would dispense with them altogether. Some form of anchorage will, however, be needed in extreme wind conditions.

All these requirements place a heavy task on the designer of military hutting, and any solution is bound to be a compromise. The new range of British hutting is described in Appendix "B".

Permanent Buildings

The army's peace-time requirements include barracks, offices, hospitals, depots and workshops. All of these are repetitive structures well suited to prefabrication.

Until recently little use had been made of new techniques for military buildings in this country, but the U.S.A.F. has placed a contract with a British firm for 750 prefabricated buildings. The War Office has also constructed some married quarters at Maresfield using an experimental system of pre-cast gypsum panels faced with no-fines *in-situ* concrete.

In Cyprus the Episkopi Cantonment is being built on the "Reema" system of pre-cast hollow concrete panels described in Appendix "B", and in France several large blocks of new married quarters at Toulouse also make extensive use of pre-cast units.

These are only small beginnings, and the new mass production methods are at present only economical when there is a large single demand, or when components in current production can be adapted to military requirements.

Conclusion

Prefabrication in building is still an expanding industry. As manufacturing techniques improve more and more components will be factory made, and while it is to be hoped that traditional skills will not altogether die out, the new methods will produce more efficient and comfortable buildings.

As far as the army is concerned, both temporary and permanent accommodation is likely to be largely prefabricated in future. Provided suitable systems and materials are used this should greatly improve our present standards of military housing.

Acknowledgements

The details of prefabrication systems included in the Appendices are published by courtesy of the firms concerned.

The Author is also indebted to the following for information and assistance:—

Military Engineering Experimental Establishment, Christchurch.

The Ministry of Housing; The Ministry of Works; The Timber Development Association; The Building Research Station.

Prefabrication Publications Ltd., who supplied details of the American Space Deck System illustrated in Appendix F.

Appendix "A"

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The Ministry of Works. Has collected detailed technical information on all types of prefabricated building. Periodical surveys are published.

The Prefabricated Building Industry Executive Committee, 15 Upper Grosvenor Street, W.1. Publishes a list of members.

The Timber Development Association, 21 College Hill, E.C.4. Publishes standard designs for timber buildings and information on timber construction.

The Modular Society, 22 Buckingham Street, W.C.2. Presents descriptions of standard components.

The Building Research Station. An analysis of costs of some current systems has been made.

Appendix "B"

New Services "Light" Hutting
(The "Twynham" Hut)

Developing Firm

Buckwyn Constructions Ltd., Twyford, Berkshire, in conjunction with M.O.S. (M.E.X.E.).

Class of System

Specialized units.

Class of Structure

Single storey framed construction with non load-bearing panels.

Components

B.S.B. bolted portal frames with obtuse angled purlins and wall rails.

Cladding of ridged aluminium or galvanized steel sheets fixed with special clips.

Linings of ½-in. insulation board or chip-board held in extruded aluminium frames.

Additional insulation of glass fibre or other materials can be inserted between cladding and lining.

Types of Building

The "Twynham" hut is being manufactured in 20 ft. and 30 ft. spans for the following roles: living huts, offices, hospitals, canteens, small workshops, and stores sheds. It replaces the existing Nissen and Romney huts.

General Information

Date of inception—1947.

Numbers built—prototypes only.

Quality and Durability—Designed as a temporary building, but should last for up to thirty years or more in favourable conditions.

Site Work Required—Small concrete foundation blocks are desirable but frames can be spiked directly into the ground if speed is essential. Flooring will normally be *in-situ* concrete, but prefabricated timber floors can also be used.

Appendix "C"

The Reema System

Manufacturer

Reema Construction Ltd., Milford Manor, Salisbury, Wilts.

Class of System

Specialized units which are not modular, but which can be readily manufactured in a variety of different sizes by adjusting the arrangement of standard forms.

Class of Structure

Single or multi-storey framed construction with load-bearing panels.

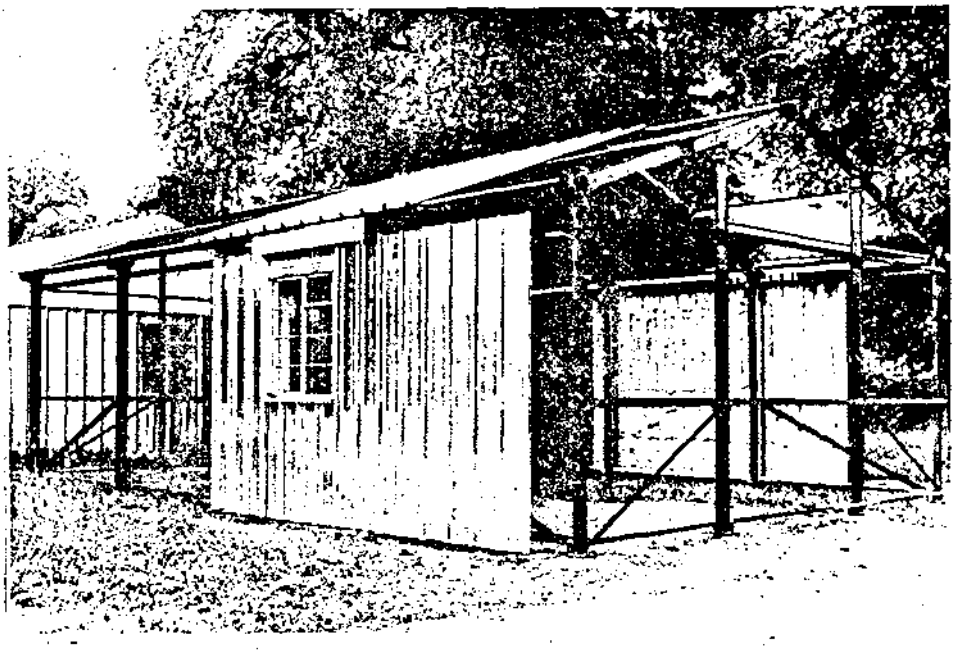
Components

Hollow pre-cast concrete wall and floor panels.

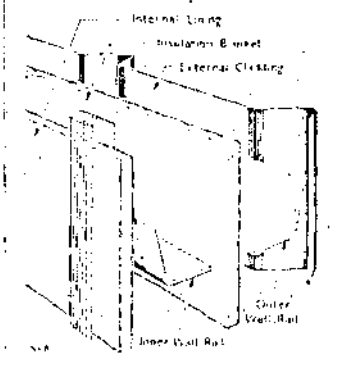
In-situ reinforced concrete frame.

Pre-cast reinforced concrete floor joists.

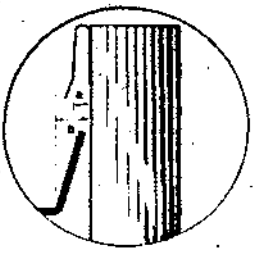
The system may be used with conventional timber roof trusses and tiles, or with precast reinforced concrete roof members.



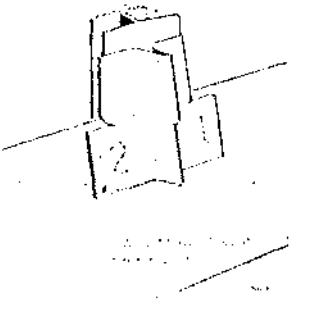
HUT UNDER CONSTRUCTION



WALL DETAIL



CLADDING CLIPS



LINING ATTACHMENTS

W. D. HUTTING

Types of Building

Originally developed for dwelling houses, this system has also been successfully used for barracks, hospitals, offices and industrial buildings.

It has recently been adapted for multi-storey blocks of flats.

General Information

Date of Inception—1947.

Numbers Built—over 10,000.

Appendix "D"

THE SECO SYSTEM

Manufacturer

Selection Construction Co. Ltd., 24 Margaret Street, London, W.1.

Class of System

Specialized modular units.

Class of Structure

(*a*) Single-storey cellular construction with load-bearing panels.

(*b*) Single-storey framed construction with non load-bearing panels.

(*c*) Multi-storey framed construction with non load-bearing panels.

Components

Composite wall and roof panels with asbestos cement facing on a woodwool cement core and timber framing.

Frames for single-storey buildings are generally of laminated timber; those for multi-storey buildings are of steel.

Floor panels are of pre-cast concrete.

Types of Building

Originally intended for temporary housing but developed to include permanent houses, offices, schools, factories and other commercial buildings.

General Information

Date of Inception—1940.

Numbers built—over 30,000 temporary houses together with large numbers of commercial buildings.

Modular Co-ordination—all components are based on the 3 ft. 4 in. module.

Appendix "E"

THE INTERGRID SYSTEM

Manufacturer

Gilbert-Ash Ltd., 2 Stanhope Gate, London, W.1.

Class of System

Specialised modular units.

Class of Structure

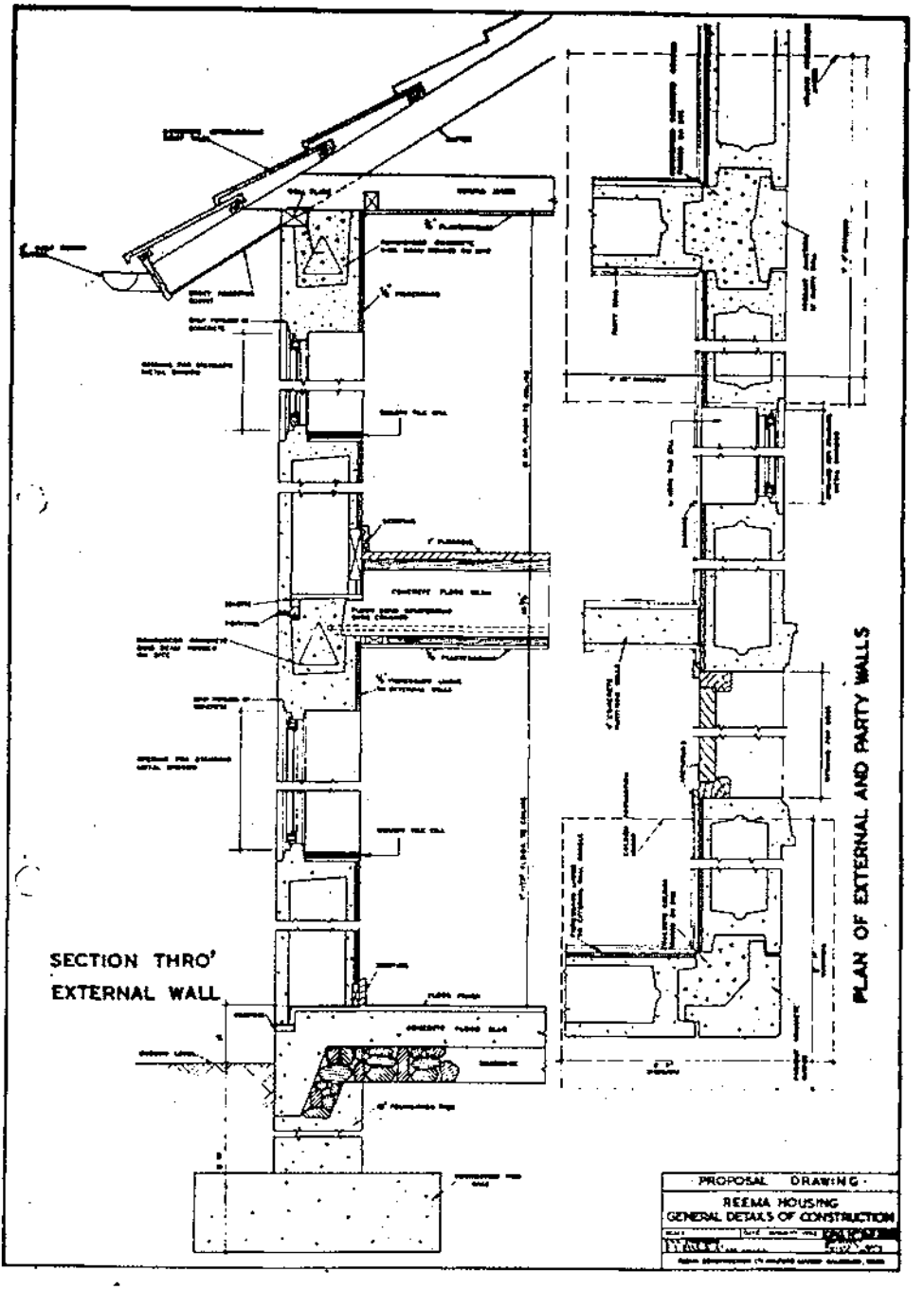
Single or multi-storey framed construction with non load-bearing panels.

Components

Pre-stressed, pre-cast concrete columns and beams.

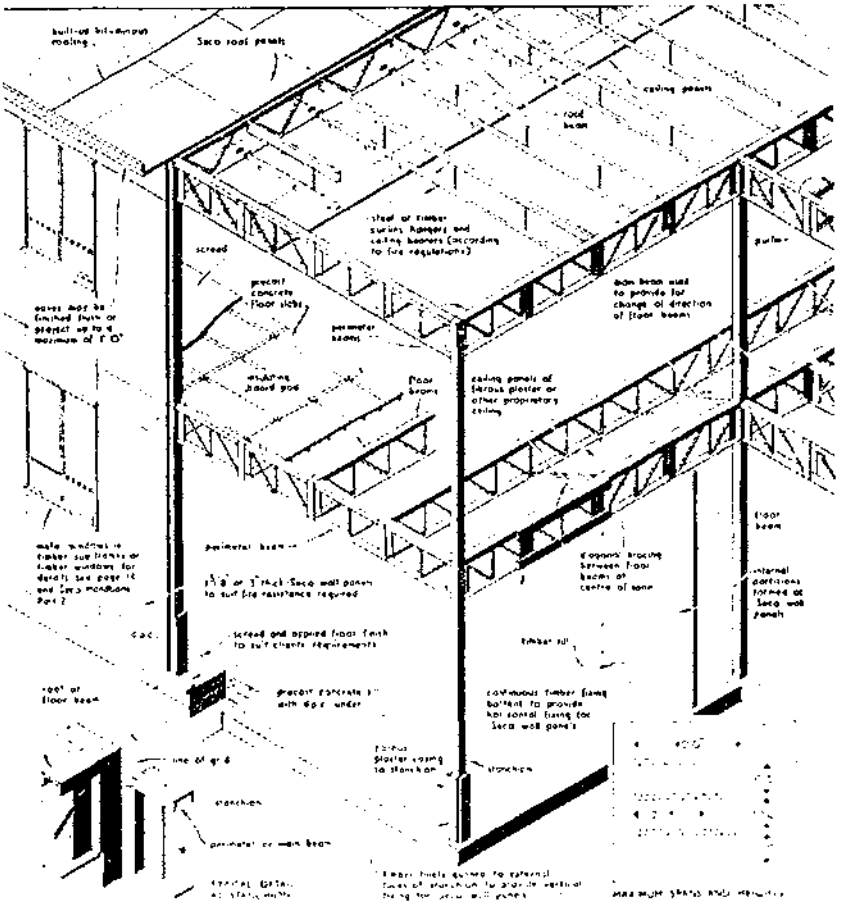
Wall panels may be pre-cast concrete, brickwork, curtain walling, etc. Inner lining may be varied to suit requirements.

In-situ floors, roofs generally channel reinforced woodwool with structural screed.


SECTION THRO'
EXTERNAL WALL
PLAN OF EXTERNAL AND PARTY WALLS
PROPOSAL DRAWING
REEMA HOUSING
GENERAL DETAILS OF CONSTRUCTION

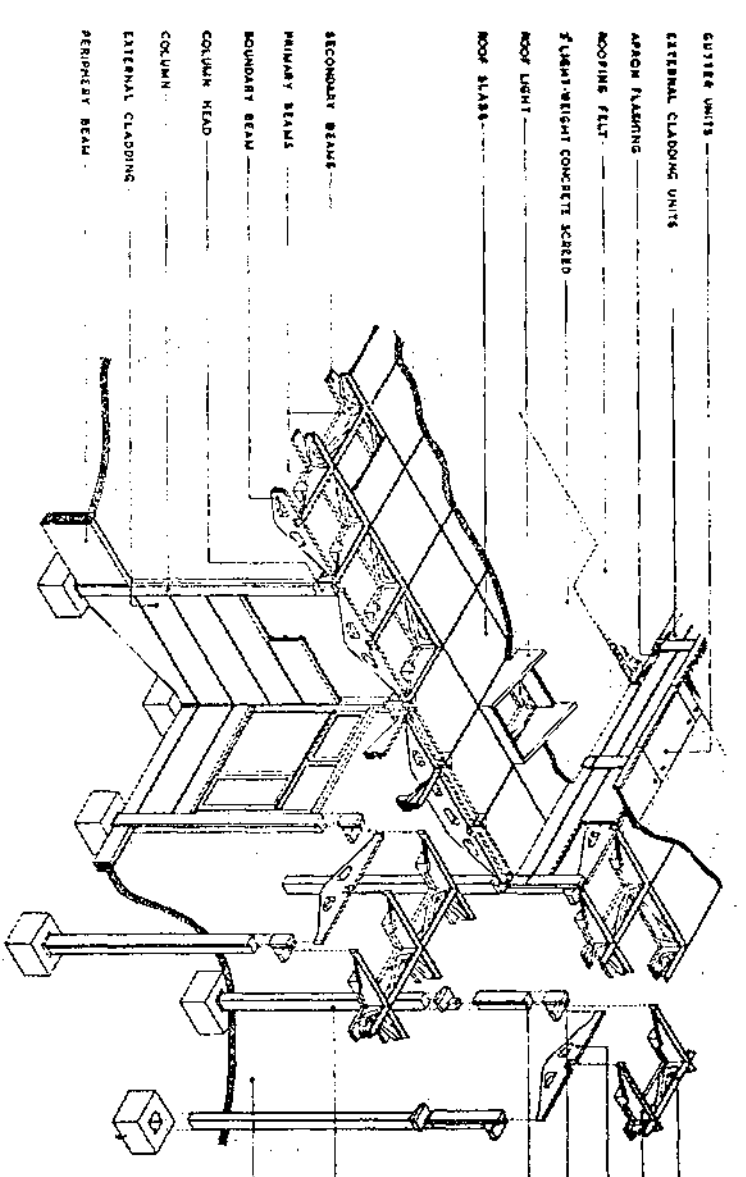
REEMA

BUILDINGS UNDER CONSTRUCTION



ASSEMBLY OF COMPONENTS

SECO



INTERGRID

ASSEMBLY OF COMPONENTS

Types of Building

Originally designed for schools, but suitable for dwelling houses, hospitals, offices, factories, and flats up to ten storeys in height.

General Information

Date of Inception—1953.

Numbers built—over sixty schools, office blocks and other buildings.

Modular Co-ordination—Horizontal dimensions to 3 ft. 4 in. module. Vertical dimensions to 10 in. module.

Appendix "F"

The Space Deck System

Designer (British system)

Messrs. Bolton, Henessy & Partners, 4 Curzon Place, London, W.1.

Class of System

Standard units.

Class of Structure

Space frame.

Components

The deck consists of 4 ft. square based pyramid 3 ft. 6 in. deep welded up from mild steel tubes and angles. The pyramids are bolted together base upwards, and their apexes are connected by adjustable tie rods in a two-way grid. These tie rods may be of mild steel or high tensile steel.

Two types of unit are in current production; a light unit weighing 72 lb. with tie bars, and a heavy unit weighing 190 lb. With continuous edge support and an all up loading of 25 lb. sq. ft. the light unit is suitable for spans up to 100 ft. square. The heavy unit with an all up loading of 33 lb. sq. ft. will span up to 140 ft. square.

Types of Building

Most suitable for large span industrial buildings and hangars.

A unit has been designed for 40 ft. span bridges to M.O.T. loading.

General Information

Date of Inception—1954.

Numbers built—roofs of two British pavilions at Brussels Exhibition. A few factories, assembly halls and stores sheds.

Possible Developments—Tentative designs are in hand for larger units with 6 and 8 ft. square pyramids suitable for clear spans in excess of 200 ft. and for stanchion supports on an 80 ft. square grid.

Designs have been commenced for helicopter landing decks and overseas bridges.

A similar experimental system being developed in America consists of two basic units only: a rolled steel channel member 4 ft. long, and a pressed steel eight-way connecting plate. These are bolted together to form pyramids as in the British system, but are not restricted to a single layer.

By building up double—and triple—storey decks, heavy bridging loads could be carried over large spans.

Corps History

By Major G. Horne, A.M.I.C.E., R.E.

The idea started through a Families Day.

These Families Days take various forms, but in a Training Regiment the main thing is that as many parents as possible are persuaded to come and see how well their sons are being looked after. The Recruiting Grant gives them lunch and tea in the N.A.A.F.I. Our recent effort along these lines did, however, include side shows, demonstrations and, to add a spot of colour, we invited some Pensioners from the Royal Hospital Chelsea.

Upon their arrival, no doubt because the journey had made them feel faint, they repaired to the W.Os.' and Sergeants' Mess bar where I was invited to meet them. After a few drinks the conversation turned to tradition and the differences between the old and the new soldier, with our gallant Pensioners strongly denying that any army could ever equal that of their day. It was then that the J.D.I., an ex-Guardsman, and the M.T. Sergeant, an ex-Marine ("Look sir, you can still see his leather neck"), started talking of Corps History and saying that they considered that more of it should be taught to recruits, as had been done in their previous Corps.

In fact, according to the M.T. Sergeant, in the Marines in his day, a recruit had to know a great deal about Corps History as well as all the names of his immediate seniors. He then went on to say how, as a recruit, he had been asked the name of the Sergeant Major and upon admitting that he did not know, had been given a spell of detention. He was a bit vague on the charge. However, all through this detention people had asked him, "What is the name of the Sergeant Major?" to which he replied "Nicolles, Sir". When he regained his freedom he knew the name of the Sergeant Major. Thus when he was next asked, "What is the name of the Sergeant Major?" he dutifully replied, "Nicolles Sir"; and was promptly put inside again as the Sergeant Major had changed during his first incarceration.

But I digress, back to Corps History. I fully agreed that the regular soldier should be taught a great deal more about the history of his Corps, and as we are dealing with the reception, and training, of all regular recruits this teaching of Corps History is very much in our minds.

Normally I do not have a lot to do with training, my interests regarding the reception of regular recruits lie in such problems as accommodation should excessive numbers rush to take the Queen's Shilling, and whether, should we get a Part II Service through to install new Cookhouse equipment, Brigade will lower the priority of the improvements to the N.A.A.F.I. kitchen. However, Corps History is something that has come my way. The C.O. knows I am interested in the days of scarlet jackets, and after all I did cause a special notice to be put in Regimental Orders for the 1st of August concerning Minden Day. Thus I had already given a lot of serious thought to the problem of getting new regular recruits really interested in Sapper History.

Strangely enough it was this Families Day which eventually supplied an answer.

We had organized side-shows, a flower show, demonstrations, meals, the band and a hundred and one other things when the question was raised by

the C.O., "What if it rains?" I explained that we had insured against rain so that in the event of it being wet we should at least recoup expenses, although S.S.A.F.A. and the R.E. Benevolent Fund, to whom the various proceeds were going, would not do very well. I even pointed out that some "idle" members of the Mess advocated laying on nothing and praying hard for rain. That, apparently, was all very well; but what were we to do with all the parents who, having travelled long distances and braved the rigours of the British Railways, would descend upon us come rain or shine? Feeding them in the N.A.A.F.I. and letting them sit in the "Spiders" with their sons would take up some, but not all of the time, so we added to this "wet weather" programme some films. We laid on *Desert Victory* in the A.K.C. Cinema, and, as a side line, were prepared to show, "The sort of films your son sees as part of his Training", in one of the lecture rooms. To select these, the Sapper section of the *Training Film Catalogue* was consulted for films that were not too long or too "restricted" to show to parents. The effects of Atomic Attack, chosen by a keen Chief Instructor, was fortunately not available, as I doubt whether the wretched parents would really have been keen on seeing the R.A.M.C. making themselves look gory. Eventually we obtained one about building a Bailey bridge for a local authority, and *Personal Hygiene*. It was really a pity it did not rain sufficiently to warrant showing these films, as I should have liked to have seen the effect of this latter masterpiece on the parents.

However, the main point is that our search through the catalogue produced nothing of a general Sapper nature apart from an hour's epic called *Sapper Tasks*. It was then that it flashed across my mind that there ought to be a film on Sapper History.

These days, films play a great part in the life of young people and it is a principle of good instruction to use a medium which retains the interest of the audience. This is obviously appreciated as more and more Training films are being produced. Quite clearly all training cannot be done by films, especially where practical work is necessary, or where questions and answers are to be encouraged. However, a subject like Corps History is ideally suited to the screen, as it is one which can easily become boring in a lecture, unless it is very well put over. I know that a film strip has been produced, but although this is a step in the right direction, I do not think that anyone will disagree that a film is the real answer. The question is would it be possible to produce?

I recall seeing in a past copy of *Soldier* that the Gunners have already made such a film. Two of the "stills" shown in the article describing this film were an Ordnance Train of the seventeenth century, and Mercer's battery galloping into action at Waterloo. The latter was portrayed by the King's Troops R.H.A., suitably clad, galloping the guns in the Long Valley at Aldershot.

Of course the planning and production of such a film would take a lot of careful thought. First and foremost there is the problem of cost. The recruiting grant includes money allotted for the production of films, and bearing in mind the needs of the new Regular Army, I feel that even the most tight-fisted member of the Treasury should not deny the usefulness of such a project.

What would the expense be? It would include the cost of the film, the employment of a professional camera crew, a producer and a commentator.

I consider that good photography, production and commentary are essential. The services of an experienced commentator would certainly be a worthwhile investment as a bad commentator is akin to a bad lecturer.

Script writers, players and props are available free from the Corps and I think that the bulk of the uniforms required could be obtained for a small cost. Sources such as our own Corps Museum and those of other Corps and Regiments, Tattoo authorities and Ordnance should produce all requirements. I know that S.S.A.F.A. have a lot of such uniforms for their White City Tattoos and my own Regiment already holds thirty Victorian helmets and tunics on long loan from them. Finally, I understand from A.K.C. that it would be possible, for not too great a cost in such a cause, to obtain extracts from old films and newsreels to include in our story.

The way to make the film would be to decentralize and keep scenes short, by allotting different episodes to various units. These scenes would be under the control of the one producer who would be working on a script prepared and checked historically, by a "Sapper Committee." They would also all be filmed by the same camera crew. For instance, given plenty of warning, an historical episode included in our recent Families Day could have been suitably modified and filmed during rehearsals. In, I think 1951, the R.E. Association held a rally in the Albert Hall, and in 1953 the S.M.E. took a prominent part in a Tattoo at Gillingham. Both these occasions produced episodes which would have been most photogenic had they been put in the correct setting. However, before going any further into detail, the question of sound, colour and size must be dealt with.

Sound is necessary as the film must have a commentary, but actual talk could be cut to an absolute minimum and dubbed at the same time as the commentary. Thus all the filming would be "silent" with no complications of microphones and recording during shooting.

The question of colour is a difficult one. I feel that historical scenes would lose a great deal of their interest and attractiveness if they were in black and white. On the other hand there is, in existence, a great deal of black and white newsreel documentary material which could probably be used. Though black and white prints can be made of a colour film, there is no process which produces coloured prints from a black-and-white film. I consider all film actually taken should be in colour and one would have to accept the fact that black-and-white newsreel and documentary sequences would be included. One possible method of cutting down the harshness of black and white after colour may be to dye the black-and-white film sepia. The film *Moby Dick* was mainly in sepia and was most effective in giving the impression of colour.

Size will sort itself out. I do not know whether 16 mm. or 35 mm. would prove the more convenient size in which to film, but 16 mm. prints will be required for use in Training Projectors. Here of course cost will be the ruling factor.

After the technicalities comes the presentation. Several methods suggest themselves including the straight-forward lecture from the screen with maps and historical scenes interspaced. This, however, is really nothing more than a "super lecture", and I consider that something a little more entertaining is required. There is of course the method of putting the clock back, starting with modern Sapper recruits reading or talking about Corps History and then showing various flashbacks. Again this rather lacks humour, which I feel one must have to sustain interest.

My own idea is to start with a party of modern recruits doing various phases of Sapper Training. This identifies the audience with those on the screen, and also gives them one or two quiet laughs as they see the actors going through some of the same "trials" that they themselves have recently experienced. This part should be kept very short.

Our film recruits are now led into a typical army lecture room for a talk on Corps History by a rather "monotonous" officer waving his 10d. copy of *Corps History*. Our hero, none other than our old friend Sapper Snooks, is soon asleep at the back of the lecture room, and as Captain Monotonous' voice changes to that of the commentator, Snooks dreams his Corps History. Snooks and his friends appearing as the eternal Sappers throughout the ages.

To finish on a comic note, as we come to modern times, Snooks is rudely awakened by an historical question being put to him by the lecturer. Snooks answers this in very much greater detail than the officer ever expected. When asked how he knows so much detail Snooks says, "I was there, sir." The film ends with Snooks, plus R.P. escort, doing his exercise walk from the Guardroom. Obviously this "first-hand knowledge" of early Sappering has cost him seven days.

Now let us consider Corps History as dreamt by Sapper Snooks. Obviously a lot of careful thought will have to go into deciding what to include and preparing the script. I have no intention of attempting to write this script, all I shall try to do is to mention various pieces of Sapper History and indicate how they could be presented. One point I should like to make is that this History should be presented at field-unit level. Masses of dates and the names of Generals are of no interest to present day young soldiers. Although a few key dates can be slipped in, the main emphasis should be on how the Corps as a whole played its part in history. Thus any audience, be they recruits, trained Sappers or N.C.Os. will be able to identify themselves with the characters appearing on the screen, and appreciate the fact that many Sapper tasks remain similar throughout the ages.

Our friend Captain Monotonous starts his lecture by mentioning how skilled the Romans were in engineering, quoting some examples. He then goes on to talk of the "Ingeniator" Waldivus of *Domesday Book* fame. By this time Snooks is asleep and perhaps we see him briefly as Waldivus. The commentator has now taken over and talks of Bishop Gundulph, a person well worth mentioning, as practically all regular recruits are destined at sometime to visit the Gundulph Pool at Upnor.

The Bishop Gundulph scene is obviously one to be shot at the S.M.E. It would include a close-up of the old man himself consulting plans, a quick shot of old-time masons at work on a stone wall, and then some scenes of Rochester Castle and Cathedral, care being taken that no anachronisms occur.

The history would now proceed with any maps or charts considered necessary interspaced between scenes. The presentation of such maps and charts is where a film strip has a definite advantage over a film. The former can be stopped on one particular map as long as is required whilst the latter is using up expensive film on what is, in fact, a "still." As even the need to build up a new keen regular army is not likely to loosen Treasury purse strings very much, these charts and maps must be kept to a minimum.

I suggest simple line maps of the area of the world under discussion with the particular country in question blocked in. This could then be followed

by an enlargement of the country with arrows indicating places of interest. Charts should be few and as simple as possible.

Early forms of warfare should prove interesting and, as it is possible to obtain prints of short lengths of "entertainment" films, some good examples, all in colour, such as the storming of Torquilstone Castle from *Ivanhoe*, the charge of the French Knights and English Archers in action from *Henry V*, and some scenes from Bosworth Field from *Richard III* might be included.

Early warfare having been shown we now come to the introduction of gunpower and the formation of the first Ordnance Train. I would suggest a look at the Gunners' film before planning anything on this period. It is possible that some of their early sequences could be incorporated into our film.

Sapper Snooks and his friends would of course have been seen building Rochester Cathedral, firing their bows and arrows and lending a hand with the early artillery.

The forming of a separate Corps of Engineers in 1716 and the granting of Military Ranks in 1757 would best be illustrated by showing the wearing of uniforms of the time. The Regiment in Gibraltar could then be given the task of showing the newly formed Company of Soldier Artificers at work in 1772 against authentic backgrounds. This would be followed by a "long shot" of Gibraltar, as seen on the front of *The Sapper*, together with some views of the Siege. The effectiveness of the latter scene would depend on the initiative of the Gibraltar Regiment. A simple chart would be useful here and should include the formation of the Corps of Royal Military Artificers in 1787 for work on fortifications at home ports, and the incorporation of the two companies of Soldier Artificers at Gibraltar in 1797.

The display of uniforms is obviously a part of the film best left to the S.M.E. and the Museum; it should also show the derivation of the Corps badges and mottoes.

The Peninsular War and Waterloo will present some difficulties. However, here I would introduce the method of photographing famous paintings of battle scenes. The Imperial War Museum, the Walls of the Senior and the Parker Gallery in Albermarle Street are but three sources of such pictures.

In the case of the Peninsular War a film called *The Pride and the Passion*, based on C. S. Forester's famous novel *The Gun*, contains some battle scenes taken in Spain. Some shots from this film would be of value, as might battle scenes from *War and Peace*, which show panoramic views of Napoleon's victory over the Russians at Borodino. A map would be of use here especially to illustrate that great Sapper project the lines of Torres Vedras. The Peninsular Campaign was a war of many sieges and Sapper Snooks and some comrades would be shown constructing a "Sap", a scene that the Training Brigade could produce in the Long Valley. This period should conclude with the opening of the Royal Engineer Establishment at Chatham, in 1812 by Sir Charles Pasley, and the granting of the title Royal Sappers and Miners. The S.M.E. might be able to produce a model of the early establishment which could be included amidst suitable close-ups of some of the present day buildings.

Waterloo was not really a Sapper's battle, in fact it was somewhat the reverse. However, as it is a battle of which even the dullest recruit may have

heard, it should be mentioned in passing, and illustrated by photographs of one or two suitably stirring pictures. The mentioning of *names*, especially those of Peninsular and Crimean battles, may savour of getting our history on rather a high level, but audiences are likely to find themselves living in barracks with those names.

To introduce the Crimean War some more photographs of pictures of famous incidents should be used, and include the Charge of the Light Brigade, the Thin Red Line and Florence Nightingale. The derivation of the phrase "Follow the Sappers" should be illustrated and Snooks and his friends shown laying the first field telegraph used on active service.

Here the commentator would refer to the incorporation of the Royal Sappers and Miners with the officers of the Royal Engineers, the derivation of the Corps of Royal Engineers, and the first use of the rank of "Sapper". This would be a suitable point to recapitulate the growth of the Corps from 1716 to 1856 by means of a chart and also to show the numbers, and any badges, of the companies which fought in the Crimea, so that recruits who go to these squadrons may recall some of their history.

Around the countryside, and especially in the Chatham and Portsmouth areas, are a number of old fortifications and I am certain that somewhere in one of them will be a rusting old muzzle loader. With this as a background, a scene inside the fortifications before Sebastopol could be set, and *Follow the Sapper* and the construction of old-fashioned fortifications duly shown. With a little enterprise the storming of a Russian battery together with the winning of one of the first Sapper V.Cs. could be included.

One of the gates of this fort, suitably disguised, should then be used for the blowing in of the Kashmir Gate at Delhi; this could be a stirring scene. The rest of the Mutiny I would leave to commentary, maps and photographed pictures of scenes including the Residency at Lucknow. At this stage a map and chart should illustrate the forming of the Corps of Sappers and Miners of the Indian Army.

The Abyssinian Campaign needs a passing mention. Possibly one or two pictures might be shown, and the fact that the 10th Company took part noted. Wherever possible mention should be made of those companies, that today exist as squadrons, which took part in the pre-Boer War Campaigns.

In Canada, I understand, Cadets, suitably dressed in uniforms of a hundred years ago, mount guard over one of the historical "Sapper-Built" forts. I am certain that the Canadian Sappers could use this, together with other scenes, to illustrate the activities of the Corps in that part of the world.

Rorke's Drift could be a stirring episode. I would suggest that scenes of the defence could be re-enacted by the Training Brigade in the Long Valley, interspaced with coloured newsreels of native Impies taken from one of the Royal tours, or else from a suitable coloured Hollywood epic of Africa, though I cannot think of one at present.

Korda's film *The Four Feathers* has a number of most useful scenes in colour, including ones of Kitchener, traversing the Nile cataracts, the breaking of the square and the Battle of Omdurman. Longmoor, no doubt, with their ample experience of filming, could produce some shots of the laying of Girouard's famous desert railway, interspaced with views of the actual desert provided by Sappers at present in North Africa.

At this stage the great age of Kipling's *Tommy Atkins* and Leslie Stuart's *Soldiers of the Queen* should be illustrated by scenes not only of the "small

wars" just referred to, but also of garrison life at home. Brompton Barracks would form an ideal background for these and I am sure that the S.M.E. could enact scenes of red-coated Sappers drilling on Brompton Square, as they did for the Rochester pageant in Festival Year, Chatham Band heading an old time church parade, a Victorian group of officers posing for a "batch" photograph on the steps of the main building and some shots showing the life of Sapper Snooks and his friends both on and off duty. Conditions of life in the barrack room together with married families "behind their blankets" would be of especial interest. A photograph of the R.E. Team which won the F.A. Cup in 1874–5 might also be shown.

These of course were also great days in India, but trying to film scenes from the frontier wars would be too ambitious. Again this would be a case for the photographing of pictures. The three films I can recall which portray early soldiering in India are *Lives of a Bengal Lancer*, *Gunga Din*, and *Rogues March*, but all three are in black-and-white. The only colour film I know of is *The Drum* and this really portrays the India of the 'thirties. Possibly India could best be used to illustrate some of the Corps activities, including Work Services, showing the E. & M. School, an old block of married quarters and the famous barrack block, in I think Gosport, reputedly built from a tropical design. All these suitably peopled, could act as examples of the work in India. Survey could well produce an Indian scene with reference being made to Major Everest. The film of *Kim* had some fine shots of the great trunk road, another Sapper achievement, and railways and irrigation should be suitably illustrated.

Here is a suitable place for one or two scenes of Snooks and his friends as Submarine Miners before the start of the Boer War.

I do not know of the existence of any film showing suitable Boer War Battle scenes, although *The Four Feathers* had a shot of troops marching to embark which could well be used. I feel that this war would best be illustrated, again in the Long Valley, by a series of very short scenes of Sapper activities such as, defence works, bridging, horse-drawn pontoon wagons (provided by the R.A.S.C. Horse Transport Company), searchlight and survey, steam road transport, railway work and finally the 2nd Balloon Section at Ladysmith. This Balloon Section in action and also a man-lifting kite should not be beyond Sapper ingenuity to produce.

With the end of the Boer War comes the great problem of whether to try and enact the many Sapper activities of the two great World Wars and film them in colour, or whether to call upon the ample available newsreel material, which is of course in black-and-white. My own feeling is that the film should be in three parts. First there would be the colour film showing the history up to the end of the Boer War which I have described in some detail. Secondly a black and white selection of newsreels, suitably commentated upon, would illustrate the two great wars. This is too large a subject, requiring a lot of careful thought, for me to deal with in this paper. The third and final part should be a coloured film, again requiring careful planning, showing present-day Sapper activities together with shots of some of those branches of the Services which were "our babies" and are now grown up. Snooks could feature fairly prominently in this last part, although it might be a little difficult to introduce him into the middle section.

These three sections should be approximately equal in length and would, in fact, comprise "three lectures". The whole of Corps History should NOT

be put over at one sitting. If it is considered that these films might be shown quite separately and not one after the other, then of course Sapper Snooks must be awakened at the end of the Boer War, rather than in Modern Times.

It is most essential that there be a musical background as well as a commentary. Obviously "Wings" and the "C.R.E." would often be heard, but so should the series of nostalgic tunes to which the British Army has marched down the ages.

Having got these ideas off my chest, no doubt I shall be marked down as an officer who "is keen on that sort of thing" and condemned to play the role of "Monotonous", clutching my 10d. copy of *Corps History*, for the rest of my stay in the Training Brigade.

Memoirs

BRIGADIER R. H. MUIRHEAD, O.B.E.

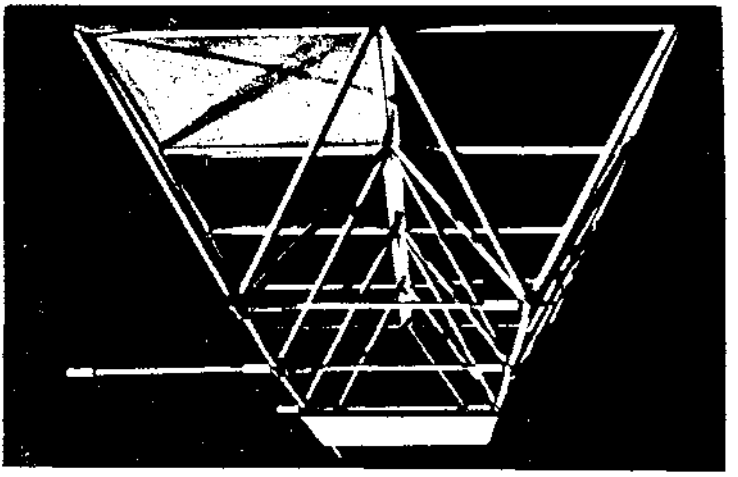
RONALD HURNDALL MUIRHEAD, who died at his home in Richmond, Yorkshire on 29th October, 1958, was born on 29th June, 1899, the son of Dr. and Mrs. R. F. Muirhead. Educated at Hillhead School, Glasgow and at the R.M.A. he was commissioned on 23rd January, 1919.

After serving in 438 Field Company, Rhine Army, he went to the S.M.E. Chatham in January, 1920, and on completion of his course was posted to Constantinople, where he joined 55 Field Company. He returned to Catterick in 1923, but next year went abroad again to serve for five years with the Iraq Levies. He received the M.B.E. in 1929 for his work in Iraq.

In October 1929 he was appointed Assistant Instructor, Field Works and Bridging School, S.M.E., where he remained for five years.

In 1936 he was selected for an E. and M. course, and in 1938 was posted to India. After two years in E. and M. appointments in Southern India he joined the E. in C. Branch at G.H.Q., where in 1941 he was selected to be one of the S.O.R.E. I charged with organizing the Stores (later Engineer Resources) Directorate, a job for which his thoroughness and meticulous accuracy made him well fitted. In June, 1942, he became C.R.E. 14 Indian Division, and in the first Arakan campaign it was largely due to their C.R.E.'s leadership and organizing ability that the Divisional Engineer units and other Engineer units which came under his command acquitted themselves very well under great handicaps.

On return to India with the Division in 1943, Muirhead again joined the E. in C. Branch, where he spent the next two years in the Air Force Works Directorate. Those were the hectic days of airfield construction, when over 150 fields were under construction at one time, and on Muirhead fell the task of finding detailed solutions to the many problems which arose from the employment of different agencies—Army, Central P.W.D., Provincial P.W.D.s, and State P.W.D.s—all suffering from chronic shortages of transport, machinery and stores. He was promoted to T/Brigadier, and received the O.B.E. in 1944 for his outstanding work.



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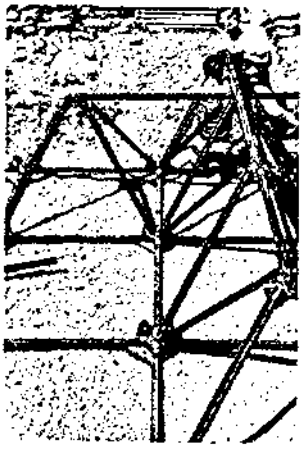

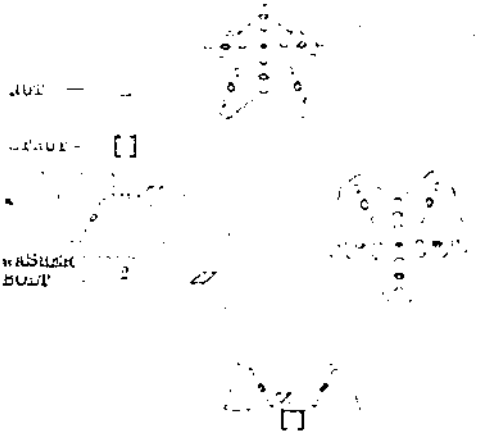

AMERICAN SYSTEM

SPACE DECK

Brigadier RH Muirhead OBE

After almost two years at home as Deputy Commander No. 1 Engineer Stores Group he went to Pakistan in the second half of 1948, and became D.C.E. and Secretary P.W.D. Baluchistan. The role of serving the Army and Air Force Commanders on the one hand, and the Agent to the Governor General on the other, was an exacting one, made more so by the shortage of engineer personnel which followed Partition. But Muirhead took it all in his stride. Among many important projects for which he was responsible at their inception were the Nari Bolan Irrigation and Hydro-electric Scheme, and the Quetta–Karachi road. The survey and planning of the former were entirely his work though the scheme was ultimately enlarged and executed by the Central P.W.D., while the preparation of the final scheme for the Quetta–Karachi road, now being executed, was also his. His departure in 1952 to join the E. in C. Branch in Rawalpindi as Director of Works was sincerely regretted throughout Baluchistan, not least by the personnel of the M.E.S. whom he had assiduously trained, guided and befriended with scrupulous fairness for four years. He himself would have preferred to remain in Baluchistan, but felt it was his duty to accept the appointment of D.W. He threw himself heart and soul into his new job which afforded unlimited scope for his experience and power of organization in coping with the large programme of new accommodation for the Armed Forces in East and West Pakistan. In his three years as D.W. his quiet, good humoured and loyal nature, his unselfishness and strong sense of justice in all things, earned him the respect and affection of both seniors and juniors.

He returned to the U.K. and retired in 1955. Fond of all games, he particularly enjoyed sailing or a game of golf.

He will be much missed by a wide circle of friends at home and in Pakistan.

He married in 1930 Elma, daughter of Mr. and Mrs. W. H. Tulley, who, with one son and two daughters, survives him.

R.K.M.

COLONEL C. de W. CROOKSHANK, D.L., J.P.

Chichester de Windt Crookshank, born on 18th October, 1868, was the eldest son of Colonel A. C. W. Crookshank, C.B., Indian Army. He was educated in France and Switzerland and at Brackenbury's School, Wimbledon, before entering the R.M.A. Woolwich, in 1885, and being commissioned in the Royal Engineers in July, 1887.

Before the end of his S.M.E. Course, Crookshank showed the width and diversity of his interests, which was to be a feature of his later life both in the Army and in retirement.

His early military career was much interrupted by long periods of ill-health, and later his regular service was ended by a serious hunting accident in 1911. The intervening years, however, provided opportunities for the full and very varied life open to Sappers of that period.

On leaving the S.M.E. in 1889 Crookshank spent seven years in India—the first three years in Military Works during which time he served with the Miranzai Expedition—Medal and Clasp—and then four years in Telegraphs

with the Bombay Sappers and Miners. On reversion to the Home Establishment he had a very happy spell in Ireland with the Ordnance Survey working on the 1-in. Map Revision.

Early in 1900 he embarked for South Africa as a junior Captain on the staff of H.Q., R.E. 7th Division. During the campaign he gained the Queen's Medal with four Clasps and the King's Medal with two Clasps, was mentioned in despatches, and was wounded. His experience up to the conclusion of hostilities in May, 1902, included work as Field Engineer, Second in Command of a Field Company, Staff Captain Intelligence and on Field Telegraphs and Railways.

Remaining in South Africa until 1906, Crookshank served as Adjutant of the Railway Volunteers before taking over in succession 5 Field Company and 2 Field Troop—the latter included a Telegraph Section carrying with it the appointment of Telegraph Officer for the whole Command.

In 1906 he was sent to Zululand on the outbreak of the Natal Native Rebellion to report on the railway facilities for troop movement—Medal and Clasp. Later in that year he was invalided home and, now a Major, he commanded in turn 3 Fortress Company at Dover and 59 Field Company at the Curragh.

Whilst in South Africa, Crookshank had come under the influence of a distinguished Sapper and pioneer of aeronautics, later to become General Sir John Capper, and on return to Home Service he developed an interest in flying and in particular in ballooning. He became a founder member of the Royal Aeronautical Club, for which he acted as delegate at several flying meetings. He attended a balloon class at Farnborough under Capper, whom he accompanied on a terrifying balloon trip from London to the Isle of Wight in 1907, and later in that year he acted as navigator in a balloon race from Brussels landing just north of the Pyrenees.

Before his hunting accident enforced his retirement as a Major to the Reserve of Officers in 1913, he was employed for a time on Works Services in Edinburgh and Weedon.

On the outbreak of the 1914 War Crookshank joined the 5th Royal Irish Regiment, but being unfit for active service took over the training of Pioneers at Aldershot. In 1916 he was promoted Lieut.-Colonel in charge of the A.A. Defences of Birmingham, and a year later returned to the Corps for Transportation duties in France.

In 1920 he accepted the invitation of G.O.C., 54 (East Anglian) Division, T.F., to be his C.R.E. He held this post until his retirement in 1924 when he was promoted Brevet Colonel, T.F., in recognition of his services.

On the outbreak of the 1939–45 War Crookshank was 71 and by no means robust, but he worked with the Home Guard in the Woolwich Zone, and later as Home Guard R.E. liaison officer in Scotland. From 1942 onwards he was much taken up with the work of the Scottish Red Cross and the St. Andrew's Ambulance. From very early days he took a keen interest in ambulance work, and in 1923 had been made a Knight of Grace in the Order of St. John.

A chance meeting in 1903 with Joseph Chamberlain in South Africa gave Crookshank his first introduction to politics and statemanship, and before the end of the 1914 War he entered the political arena. A narrow defeat at Yarmouth in 1922 preceded his election to Parliament in 1924 as a Conservative for the Berwick and Haddington division. Owing to ill-health he

withdrew from the 1929 election, but two years later won Bootle from Labour. In the House he took a particularly active interest in Scottish affairs, in the Parliamentary Commercial Committee, and in the Empire Parliamentary Association; he was a member of delegations of these two bodies on visits to many countries.

On ceasing to be a M.P. in 1935 he continued his interest in many kindred activities—he was Hon. Treasurer of the Committee of the History of Parliament, and an Hon. Secretary of the International Parliamentary Commercial Conference.

For a man who did not enjoy the best of health either during his army career or later, Crookshank lived an exceptionally full life. His outdoor activities were those of the country gentleman of his time, polo, hunting, fishing, and shooting. He was widely travelled, and intensely interested in archaeology, art and history, and it was this interest which led him to his unique study of the history of the British Army as portrayed in pictures and prints. He started his serious work in 1907 and by 1919 had amassed a splendid collection of more than 1,500 items. In 1921 he published the standard book on this subject under the title *Prints of British Military Operations 1066–1868* for which he was awarded a Gold Chesney Medal by the R.U.S.I. in 1933. His collection, which was exhibited at the Guildhall, 1931, at the R.U.S.I., 1933, and in Edinburgh, 1948, was accepted as a gift to the Nation by the Government and is now housed in part in the British Museum, and in part at the R.M.A., Sandhurst.

He was a Fellow of the Society of Antiquaries, and played a leading part in the work and meetings of the Royal Archaeological Institute, and of the East Lothian Antiquarian Society.

Crookshank was appointed to H.M. Bodyguard of the Honourable Corps of Gentlemen at Arms in 1920. He presented their Mess in St. James's Palace with a picture of the Battle of the Spurs, and wrote a short history of the Corps which was published by the Royal Archaeological Institute. He undertook, in collaboration with Garter King of Arms, the design and production of a Bodyguard Standard which was presented by the King in May, 1937. He ceased to be a member of the Bodyguard on reaching the age-limit in 1943. In 1929 Crookshank had, in addition, been appointed to H.M. Body Guard for Scotland, The Royal Company of Archers.

Living at his wife's old home in Scotland, he took a leading part in public work and was both D.L. and J.P. in East Lothian.

He married in 1910, Mary Usher, the younger daughter of Andrew Usher, D.L., of Johnstounburn, Humbie, and is survived by his wife, three sons and one daughter.

A very wide circle of friends learnt with a real feeling of personal loss of the passing of a wonderfully humble, kind and cultured companion, when "Crookie" died at Johnstounburn a few days after reaching the age of 90.

R.S.R.-K.

COLONEL L. CHENEVIX TRENCH, C.M.G., D.S.O.

LAWRENCE TRENCH came of a well-known family of French extraction which has long been distinguished in the public life of Britain. He was born on 24th March 1883 at Shoeburyness, where his father, Colonel Charles

Chenevix-Trench was Chief Instructor at the School of Gunnery. His mother, the daughter of a soldier, had a family of one daughter and seven sons, of whom Lawrence was the fifth. Five of the boys became regular soldiers and a sixth served in both wars on a temporary commission. Lawrence spent his boyhood close to London and was educated at Wellington. Here he developed a taste for languages so that later on he learned to speak excellent French and German, as well as becoming a first-class interpreter in German. Passing high out of the "Shop" he received his first commission in the Royal Engineers on 21st December, 1901. His early years in the Corps were spent uneventfully with field and fortress companies R.E. at Aldershot and Gibraltar. Although lacking particular aptitude for games and sport, he tackled them all with zest and could ride, shoot and fish as well as most. Whether in uniform or plain clothes, he was always very particular about his turn-out.

In April, 1914, he was in command of 4 Fd. Tp. R.E. during the famous "mutiny" at the Curragh, where he stoutly refused to sign the declaration that he would resign rather than fight against Ulster. In after years he often expressed the view that soldiers should not be asked hypothetical questions of this kind—a dry comment which was typical of him.

In the first war he served with distinction throughout its course, starting in 1 Fd. Sq., R.E., and finishing as C.R.E. 62 Div. He was wounded and several times mentioned in despatches, besides receiving the D.S.O. (immediate award), C.M.G. and Legion of Honour as rewards for his services. In 1921 when at the War Office, he received a Carnegie medal for bravery in stopping two runaway horses and a dray in a crowded London street, as a result of which he had to spend some time in hospital. After his recovery, he went as a nominated student to Camberley, proceeding thereafter to Hong Kong as G.S.O.2. From here he travelled extensively in China and visited Quemoy, which was then an obscure island off the coast hardly worth attention. Between 1926 and 1932 he was back in old haunts at Chatham and Aldershot and spent his period of command as C.R.E. 2 Div. In promotion to Colonel, he went off to India as A.Q.M.G. Northern Command. Refusing a further appointment in India, he retired in 1937. But the charger of military life, which he sat so calmly, still had a curvet or two left for him. In 1940, for instance, he found himself Commander of a base sub-area in Boulogne with the Germans advancing on the town. Ordered to withdraw, he saw to it by some preliminary drill, that the base details marched fully armed to their ship in good order and with military discipline. In the same year he gave proof of his quite exceptional honesty of outlook when Commander of a sub-area in Western Command. Here he disagreed profoundly with higher authority about what he considered to be panic plans for preventing improbable German landings on the Welsh coast. Retiring for age soon after this last fling against error and waste, he busied himself with Civil Defence and other administrative activities. The Royal National Institute for the Blind, of which he was a member of the Executive Council, provided the abiding interest of the last years of his active life. In 1955 he was overtaken by a long and vexatious illness which he bore with calm courage, until released quite suddenly on Armistice Day, 1958.

In 1908 he married Winifred Ross, daughter of Edward H. Tootal, who survives him with two married daughters and six grandchildren.

B.T.W.

COLONEL R. C. GRAHAM, O.B.E.

RODERICK COVERLEY GRAHAM died on 1st October, 1958, as the result of a tragic accident. Born on 29th August, 1904, he was educated at Clifton and was commissioned in the Royal Engineers on 26th August, 1924. After his time at the S.M.E. he spent two years in England in Works and with a field company and then went to India.

J.S. writes:—"I first met Charles Graham in April, 1933, when nine of us joined the newly-formed combined P.W.D. in the North-west Frontier Province. Our seniors were all found from the Irrigation Branch, and Sappers were needed to help out with the Civil Roads and Buildings which had hitherto been a purely military responsibility.

Charles served as S.D.O. for the Kohat District where I had served for six years. He was on his own and his keenness and drive were immediately evident in maintaining the standard which we had only achieved with a far more lavish staff.

He did so well that he was chosen as the first of us to be trusted with an irrigation project of his own. An old inundation canal taking off from the Indus some miles up from Dera Ismail Khan was to be made perennial and Charles was put in charge of the headworks. These consisted mainly of heavily armoured bunds and spurs that involved a tremendous amount of earthwork and stone-dumping. He built his own rest house and zestfully enjoyed the independence, the hard work and the isolation, to say nothing of the shooting and fishing.

The job was completed so successfully that on the opening of the canal which coincided with his marriage, he was given the important Roads and Buildings Sub Division at headquarters in Peshawar. There he remained as a keen engineer and a kind host to outstation visitors until his tour with the P.W.D. ended."

While in India he contracted sprue which necessitated a long absence from duty and affected his health for the rest of his life.

The outbreak of war in 1939 found Graham at the War Office (Q.M.G.-IO.); after spells as O.C.T.U. instructor, second in command and commander of a field squadron, he went on a staff course at Camberley. There followed a period commanding the field park squadron in the Guards Armoured Division and two years back in the War Office in the Military Training Directorate before becoming C.R.E. 48 Division. He later joined S.H.A.E.F. as S.O.R.E. I Admin. Engr. Planning, going to France in October 1944, and subsequently moving to 21 Army Group Liaison Staff.

At the end of the war Graham spent two years with the organization charged with the frustrating task of trying to persuade the liberated countries to destroy German U-Boat pens and installations set up for the bombardment of England.

He then went to B.A.O.R. as S.O.R.E. I (Ops and Trg.); D.C.T.S. writes:—"He was in charge of all operational matters affecting the employment of engineer troops. In the main this involved a very close liaison with the C.C.G., the R.D. Division of which was responsible for the demolition of German fortifications and Flak towers and for the removal of minefields.

He was next appointed C.R.E. Berlin, where he was directly responsible for the demolition of the Flak tower which achieved so much publicity. This however, was but a minor part of his employment, because he had not been

Colonel RC Graham OBE

in Berlin for many weeks before Russian activities and intransigence necessitated the setting in motion of the celebrated air lift.

For this job and during the ticklish period of political pressure which coincided, Charles Graham was in his element. His ability to decentralize to subordinates, allowing himself the time to think out and anticipate future problems showed him at his best as the engineer adviser to G.O.C. British Sector of Berlin.

Whatever the stress under which he was working he always showed both to his superiors and subordinates an attitude of quiet confidence—he never lost his sense of humour."

In recognition of his work in Berlin he received the O.B.E.

In June 1950, Graham was appointed A.Q.M.G. at H.Q. Northern Command where he remained for two years, after which he joined S.H.A.P.E. in Paris, as Assist. C.E., Logistical Section. His last appointment, in March, 1954, was as C.E. East Anglian District. Here he was confronted with the major problem of preventing erosion on Landguard Spit which guards the entrance to Harwich Harbour. He was able to draw on his Indian experience and used "tarangas"—wire-meshed mattresses filled with boulders—to stem the water with great success.

Graham had a flair for administration and no detail escaped his notice, however small. Once he decided that something was necessary, he let no obstacle stand in his path, and so often he seemed to know the right person to help him. He was a perfectionist and although as a regimental officer he chased his subalterns relentlessly on matters of administration, discipline and behaviour, they all loved him.

He was a generous host and an entertaining companion; he was keen on all forms of sport, more particularly racing. Latterly he and his wife raced their own horses. Since his retirement in April, 1957, he had been working with a leading firm of civil engineering consultants engaged on public works in this country.

He married in 1935, Violet Agnes, the daughter of Mr. and Mrs. Charles Grabham, who survives him.

F.C.W.F.

COLONEL MAURICE MALCOLM JEAKES, M.C.

MAURICE JEAKES was born on 10th October, 1895, the elder son of the late Rev. and Mrs. J. M. Jeakes. He was commissioned in the R.E. on 10th November, 1915, having been awarded the Sword of Honour at the R.M.A.

In 1916 he served with the Mediterranean Expeditionary Force and the Egyptian Expeditionary Force and in 1918 he was transferred to Mesopotamia. He was awarded the Military Cross in that year.

In April, 1921, he went to India and was attached to the Q.V.O. Madras Sappers and Miners. He served with that Corps during the rest of his military service.

Maurice Jeakes was an outstanding personality and a very lovable character. He had a very wide range of interests and excelled in all of them. A first-class horseman he commanded the Madras Sapper Field Troop from 1922 until 1927 when he became Adjutant of the Corps. At the end of his term as

Colonel MM Jeakes MC

Adjutant he held various senior posts in the Corps and became officer in charge of Workshops.

His ambition was to command the Madras Sappers but with two officers just senior to him in the Corps his chances of doing so were negligible. It was a great wrench to him when he gave up hopes of command and retired in 1936.

R.C.R.H. who knew Maurice well during his service with the Madras Sappers, and after, has written this note about him:—

"My memories of Maurice when I was commanding are of a very efficient and loyal officer, devoted to the Corps and with a very cheerful and attractive personality. He was fond of all outdoor sports but his chief interest was in mounted sports and he was the mainstay of the Corps Polo.

When he abandoned all hope of commanding the Madras Sappers he retired in 1936 and he was given the job of Assistant Secretary Madras Race Club. He eventually became Secretary of that club. As usual he was popular with all, officials, trainers, and jockeys. It was a job that suited him with plenty of out-door interests, such as the garden and the farm run by the Club, in addition to the actual course and racing. When war started in 1939, Maurice was recalled and everyone was delighted when he came back to the Madras Sappers and succeeded in his ambition to command them. What he did to keep up the spirit of the Corps and maintain the supply of trained reinforcements is known to all and the performances of the Madras Sappers in the field are proof of it. It was always a great pleasure to go round with him and see the men under training.

The Boys Battalion, which was raised in his day, is a lasting tribute to his energy and administration. One of the sports he did much to encourage amongst the Boys was boxing and except for the first year, when they were beaten by the eventual winners, the Boys Battalion team has won the Boys Battalion Boxing competition every year.

In all that Maurice did for the Corps he was ably supported by his wife, Kathleen, who did a great deal for the welfare of the wives and families and the results of her efforts are seen today.

After the war, Maurice returned to the Madras Race Club and took on the job of Handicapper, but, with a house in England to be looked after, he felt that absence for more than half the year was unfair to himself and Kathleen, so he returned to England for good."

In the eleven years of retired life that followed Maurice took a very active part in local affairs. It is not possible to give here more than a brief outline of all his interests. In 1950 he became county Treasurer for the Distressed Gentle Folks Aid Association in Berkshire. He carried out many duties connected with Bucklebury Church which was his parish church. He was a regular reader of lessons from 1951 until his death, was Treasurer of Church Accounts and became a Church Warden in 1957. He took a great interest in the Boys Scouts Association becoming District Commissioner in 1951 and Berkshire County Treasurer in 1956. He was a member for many years of the local branch of the British Legion and was Chairman from 1953 to 1958.

Maurice continued in all these activities until his sudden death in December, 1958. Few people can have achieved so much in their retired life and it is not surprising that the service in his memory in Bucklebury Church was a crowded and a very moving ceremony.

Throughout his life Maurice did all things with distinction and style. He was a constant delight and at all times and everywhere he created a feeling of warmth and cheerfulness. He was loved and respected by his many friends who will greatly mourn his passing.

T.P.B.

COLONEL H. T. G. MOORE, C.M.G., D.S.O.

HERBERT TREGOSSE GWENNAP MOORE was born on 12th March, 1875, and was educated at Bradfield College and the R.M.A. Woolwich.

In August, 1894, he was commissioned in the Royal Engineers and underwent his Sapper training at Chatham, after which he went to Aldershot, and in 1897 accompanied the 17th Field Company from there to take part in the South African War.

In 1903 he joined the Ordnance Survey at Bristol and was given command of the 13 (Survey) Company. He was selected to join the Yola-Cross River Boundary Commission in Nigeria in 1907, and was engaged for two years on this Survey work, for which he was mentioned in despatches.

In 1909 he first gained practical experience in signals work when he joined the 2nd Air-Line Telegraph Company in Limerick, and afterwards stayed there with B Signal Company until, in 1914, he moved to Chatham.

Throughout the First World War he worked as a Sapper Signalling Officer with the Expeditionary Force, first as a Major with 7 Corps Signal Company, when he was awarded the D.S.O., and then in 1916 as Deputy Director (T/Col.) Signals, First Army. In 1919/20 he became successively Chief Signal Officer of First Army, IX Corps and X Corps Rhine Army, and Southern Command in the U.K.

Towards the end of the war he was made Brevet Lieut.-Colonel and in 1919 he received the C.M.G. for his services, and in 1920 he transferred to the newly formed Royal Corps of Signals. From 1925–29 he became Officer in Charge of Records of the Royal Corps of Signals until he retired in 1929.

He married Ethel Freda Phillips in 1909 and had one son and two daughters; his widow and two daughters survive him. He died on 9th November, 1958, aged 83 years.

E.E.N.S.

Correspondence

The Editor,
Royal Engineers Journal

Sarum,
13th January, 1959.

Dear Sir,

"Whither the Corps" by Brigadier J. B. Brown is a stimulating and constructive paper, which spotlights the problem of technical training of officers at a time when the loss of the Works Service compels us to look for alternative ways of providing the training it has afforded for two and a half centuries. But in over-emphasizing that side of our duties Brigadier Brown gives an impression of the Corps which is too gloomy. It is true that technical training has suffered in recent times, for reasons beyond our control; but the problem as a whole is to strike the proper balance between the military and the technical in the limited period of an officer's career. But let it be said at once that the main duty of the Corps can only be to assist the Army in its operations in the theatre of war and its peace-time activities must be directed to that end. The many and divers services which it has rendered to the country in peace are the rich by-products of its training for war.

In 1912 the Commandant of the S.M.E., Colonel Capper, in a "straight talk" to officers, was deploring the loss of prestige and status of the Corps, which had resulted from the recommendations of the Esher Committee in 1902 and other government investigations which followed. Till then the Director-General of Fortifications, General Sir Richard Harrison who was also Director of Works and Inspector-General of R.E., had been one of the five military officers who reported direct to the Secretary of State for War. Like many other Royal Engineers at that time, Colonel Capper felt that the prestige of the Corps had been overthrown and in his analysis of the causes of our decline he doubted if we were sufficiently developing our powers of leadership, deprecated our exclusiveness and advocated a much more military outlook. Perhaps we had become rather too technical; if so, the history of World War I was soon to show that he need not have worried much.

In 1935 General Dobbie, on relinquishing the appointment of Inspector of R.E., and also addressing the S.M.E., said he believed we had reached "a fork in the road." He thought the Corps was puzzled and groping and in need of guidance: that there was a danger we might "fall from our high position." Had he been able to foresee what the Corps was to achieve in World War II; and had he known, for instance, that eighty Royal Engineers were to hold the rank of Major-General within the next ten years, he might perhaps have felt a little less uneasy.

This is how he thought the balance between the technical and the military should be struck: "Generally speaking, in the Corps we need officers who are good all-round military engineers and who have in addition specialized in some particular branch of their profession. These officers are not specialists in the civilian sense of the word. I think that before an officer specializes in this way, he should first of all make himself a reasonably good all-round military engineer, and should in addition get a sufficiently comprehensive view of the Army and of the Corps activities so that he can intelligently choose a subject to which he will devote his special study . . . After he has specialized in this way, he should be principally employed on the subject he has chosen. . . . He must from time to time come back to the Corps for general duties in order to keep his hand in and in order to fit himself to be a C.R.E.

"In addition to these specialists to whom I have just referred, there is room in the Corps for a small number of what we may call super-specialists, who approximate more closely to the civilian conception of the term . . . The number of such that we can afford to carry in the Corps is very strictly limited."

This is a fair description of the "complete" Royal Engineer and in spite of the vast

changes in weapons and tactics since the time of General Dobbie's address it would not be easy to work out a better formula today.

As for the super-specialist, we have always had a place for him in the Corps and have always attracted a number of young men of exceptional technical ability to fill this role, though their activities have varied according to the opportunities of the period. They have achieved fame for themselves and the Royal Engineers but must never be confused with the normal run of capable R.E. officer who has no memorial but has always been the mainstay of the Corps.

With regard to military duties outside the Corps, General Dobbie added: "I personally am convinced that adequate representation of the Corps on the Staff and in Army Commands is essential for the well-being both of the Corps and the Army . . . The qualities produced by the engineer training which we have been considering definitely help to fit us for the staff or command." This is no less true today than it was in 1935, because our scientific and mathematical training help us in some degree to dissect military problems and see right inside them, and we learn, as engineers, to take real responsibility young.

We had all been brought up, General Dobbie said, on the dictum "soldiers first and engineers second" and this was a sound doctrine in so far as it could be equally applied to all other branches of the Army. "Gunners are soldiers first and Gunners second, in the sense that they are firstly members of the Army and secondly, members of the Royal Regiment—in fact, on the principle that the whole is greater than the part."

The military engineer must have a military outlook and anyone who would like to reverse these priorities should surely have chosen to be a civil, rather than a Royal, engineer in peace-time. In any case, no commander under whom we serve in peace or war will have much use for an officer who regards himself as a soldier second, however much he may perhaps respect his ability as an engineer.

In recent years the pendulum has swung too far away from technical training and for this there are a number of reasons, among them being:—

(*a*) The effect of the last war, which delayed or curtailed the technical training of Y.Os. and other newly commissioned officers.

(*b*) Its effect on captains and majors who marched, when they could, to the sound of the guns and thereby missed much of their normal technical experience.

(*c*) The progressive deterioration of "Works" as a training ground for R.E. officers. This had already set in by 1935 when we had to call in civilians and R.Os. to supplement our R.E. manpower; and though it has since provided very fine training for many of us, it has become increasingly frustrating, and sometimes humiliating, to others. Too many officers have been drawn to it more by the prospect of promotion than the likelihood of gaining the technical experience they have needed; and being over-committed on Works has not only lowered our standards but has also kept us away from other civil engineering activities from which we could have got great benefit.

(*d*) Emphasis on the duties of field units and the need to keep them up to strength owing to a series of small wars or emergencies in the Far East, the Middle East and Africa ever since the end of World War II, as well as the high state of preparedness which has been necessary in B.A.O.R.: all this at a time when the task of the regular in training and administrating a never-ending flow of National Service recruits has made the labour of Sisyphus a mere picnic by comparison.

Technical training of the whole Corps has certainly suffered but first things have had to be put first especially when they have been operational; and the Corps has, after all, been performing the very duties for which it exists.

Brigadier Brown is not fair to field units or our attitude to their training; and he seems to underrate their importance. Except in Germany, training in equipment engineering and basic field engineering since the war has, in fact, been far too sketchy for the demands of mobile operations and one has only to look at any squadron on a night bridging exercise which has not been doing much bridging of late to see how far it falls short.

One of the main reasons for this is obviously National Service, but another is the large amount of real engineering that field units have been doing in overseas theatres, and doing with great success. By "real engineering" is meant the practical handling of men, materials, equipment, machinery and transport with basic knowledge and real experience of their natures. Erecting a Totem Pole may sound a very simple task, but the article in the same number of the *Journal* as Brigadier Brown's makes it clear that it was not a suitable one for amateur engineers. It is true that field units have often been guided by good engineers in the local Works Service but field units have contained plenty of officers who could have done most of this work very well themselves and only needed a little information as to local practice—just as any civil engineer would have needed it. In other cases the attachment of a specialist or two was all that was wanted.

Here one might add that some of the tasks that field units have had to do abroad under the general description of "Works" have been quite useless, either as engineering or trade training. Such work has sometimes been absolutely necessary for the health or welfare of the troops, and then it has been our privilege to do it, but when the time available for training is so scarce we must shun tasks of no training value that may be pressed upon field units simply as a matter of administrative convenience.

Before concluding this letter a few details should be looked at:—

(*a*) Brigadier Brown says a good deal about design and everyone will agree that it is a very satisfying experience, from our Meccano days onwards to build to one's own ideas, but the word "design" may mean all things to all engineers. While the civilian consultant is usually concerned with saving the last penny, the Royal Engineer should more often be interested in saving the last minute; and in any case, civil engineering design is often a very specialized matter, in the details of which the Royal Engineer, like the civil engineer, is most unlikely to be able to compete successfully unless he has devoted much of his career to that particular aspect of it. The Corps as a whole have seldom been specialists in any constructional designing except fortifications: thus, Royal Engineers supervised the building of Brompton Barracks in 1804 but there was nothing unusual in the fact that a civilian architect, Mr. Wyatt, designed them.

(*b*) There is a great deal to be said for teaching young officers to take off quantities and prepare specifications especially, as Brigadier Brown mentions, since this is required by the civil Institutions. But it is open to question whether the extreme accuracy, and the slowness, of the civil techniques is what is really wanted by the military engineer rather than something in the nature of the stores list included in the old "(*f*) Project". Brigadier Brown is not correct when he says that quantity surveying has never been taught to young officers at the S.M.E.; it was taught many years ago and was to form part of the promotion examination from Lieutenant to Captain.

(*c*) It is no good hankering after the eminent position we held at one time in the civil engineering world. That is a false god. When, during the last century the British were developing new continents it often happened that the only engineers available were Royal Engineers, a situation which offered immense incentive to our officers, some of whom devoted most of their lives to particular civil engineering projects such as railways and irrigation and became justly famous. By a coincidence, a complementary process took place in Europe. For lack of any large war between Waterloo and the Crimea, many of the ablest members of the Corps were driven into civil engineering either to escape from the thankless and ill-paid task of repairing bad barracks or to justify their own existence. The Industrial Revolution and development of Science provided the opportunity to break new ground: the Prince Consort's personal backing for the Corps clinched it. Given comparable opportunities we would rise to the occasion today; and no one knows what lies ahead. Above all, we must remain a professionally capable and very versatile Corps of military engineers, ready to develop and exploit the advance of science for the direct or indirect benefit of the Army.

(*d*) Employing Field Engineer units on suitable civil works has great attractions and we should do this when we can. A return to an all-regular army may make it possible to have perhaps a three-year training cycle including such tasks for field

units. But one must be realistic about it and recognize the limitations to the employment of field engineer units on major works, except where operational necessity justifies a concentration of our small resources. For instance, how many working numbers can a field squadron at 75 per cent of Peace Establishment produce? How many of the men can be employed at their own trades? How will the unskilled labour be provided? And how many lieutenant-colonels per annum can really benefit from unit tasks of this sort?

Brigadier Brown writes of the necessity of retaining the respect of the Army but in fact he says more about our position vis-a-vis the civil engineer.

The real, and only, way to retain the respect of the Army is to continue to provide what it requires from us and, in particular, to deliver the goods on operations, alongside the fighting troops as we have always done with scaling-ladder, wool-bag and gabion, mine-detector and AVRE, and other less exciting forms of equipment. It is in war that our prestige has always been highest, not in peace when we are much too apt to become "the forgotten Arm".

Lord Montgomery has said "The Sappers rose to great heights in World War II and their contribution to victory was beyond all calculation"; and even this praise is excelled by Lord Canning's eulogy of the Engineers of the Indian Forces, "not as a compliment, but in the words of sober truth", on his presentation of the V.C. to Major Innes in 1857. It is on this sort of verdict that our prestige in the Army has always depended, but to earn it we have first to be good military engineers, and future war with its emphasis on speed of movement, devastation and improvisation looks like making greater demands on our technical ability than ever before.

Brigadier Brown says we compare unfavourably in technical knowledge and experience with civil engineers, but how can it—except in special cases—be otherwise? Not many of us can beat them at their own specialized game; but he is right in saying that the civil and military engineer are complementary to one another, at least in any war that is too big for the resources of the Regular Corps; and we must be good enough at civil engineering to understand civil engineers and to be understood by them and to hold their confidence as military engineers—the engineer who can turn his hand to engineering of all kinds, as the civil engineer is not so often able to do. It will be our duty not only to convert civil engineers to military engineers in war but also, as advisers to senior commanders, to co-ordinate their work. Apart from which, many regular Royal Engineers are likely to serve under their command.

Associate membership of civil engineering institutions has become very fashionable. It is, to a certain extent, a gauge of an engineer's ability though some of the ablest and most experienced engineers in the Corps today do not possess these qualifications. But they do provide a valuable link between the civil and military engineer and help to establish mutual confidence. As many of our officers as possible should possess them for that reason alone, quite apart from the incentive they provide and the standards they enforce.

Moreover, the closer contact with civil engineers which associate membership fosters must help us to recognize more quickly those trends in the advance of engineering which we ought to develop for the benefit of the Army.

In discussing civil engineering qualifications and experience, we must be on our guard against the plausible assertions of some officers who have already received a great deal from the Corps in the way of degrees, civil engineering qualifications and engineering experience and are disappointed because they may not be getting more. It is easy to understand that, in certain cases, their disappointment should be increased by anxiety about becoming redundant but, much as one sympathizes with those whose prospects have recently deteriorated, any officer who has come to regard the Corps only as a means of obtaining civil engineering experience within it and a good job in civil life afterwards has already ceased to be a Royal Engineer at heart.

The whole problem still boils down to a matter of time. How much civil engineering can we manage to do and still be good military engineers? The answer must depend to a great extent on the ability of our young officers to assimilate engineering

knowledge quickly and make use of their experience. There is no reason for complacency, but if the military and engineering capabilities of our Y.Os. remain high their services to the country as a whole should be no less valuable in the future than they have been in the past. The Army will need them just as much and the standing of the Corps will remain high within it. With the help of the Corps they will be able to seize opportunities of civil engineering experience when they appear, and their lives will be full and varied.

Moreover they will remain in the unique and enviable position of being the only corps of officers in the Army who are wholly combatant and at the same time fully technical.

Yours faithfully,
FABIUS M CUNCTATOR

Directorate of Military Survey.
The War Office, London, S.W.1.
15th January, 1959.

The Editor,
Royal Engineers Journal

Dear Sir,

Probably most will agree with Brigadier Brown that a fair proportion of Sapper officers should be demonstrably qualified as engineers. Only thus will the community of civil engineers readily accept them as competent. But it is doubtful if the means he proposes are either appropriate or really feasible.

To be acceptable the professional qualification must be one that is widely understood and respected. Membership of our own Institution carries no professional status, and any attempt to give it such is faced with a number of difficulties: what field of engineering is it to cover, or is it to be a hotchpotch of several? Who will set and mark examinations? Will the standard be accepted in the civilian world? How long will it take to gain universal recognition?

Meanwhile, there are several well-known and accepted professional engineering qualifications outside the Army. Already numbers of officers, aided by their training and experience in the Corps, have taken the trouble to qualify in this way. This should be encouraged.

Possession of one of these civilian qualifications is the best guarantee of professional respectability in the eyes of our brother civil engineers. It is also a key to subsequent employment for those who for any reason leave the Service early. A good prospect of employment both in, and afterwards, outside the Service is likely to enhance recruitment.

In the interests of fairness, and as an added inducement, there seems no good reason why the Army should not bear the cost of qualification of those who can achieve it, though without becoming involved in liability for the subsequent subscriptions for continued membership of the chosen professional body.

Yours faithfully,
A. H. DOWSON, Brigadier.

Headquarters,
Northern Command, York.
21st January, 1959.

The Editor,
Royal Engineers Journal

Dear Sir,

The new Works Organization has undertaken to house the Army in peace, but hands the task smartly back to the Corps in war, which is why 180 officers and 370 other ranks are to be set aside from our available manpower for Works training.

Peace and war are extremely elastic terms under present conditions, and it is not difficult to imagine locations and circumstances of a cold war or even a hot peace, in which the new Works Organization would be quite unable to cope with the temporary accommodation problem of the Army; to be realistic, it is an organization equipped

to work where contractors can work and nowhere else, and it is primarily designed to produce permanent accommodation.

This being so, it ought to be possible to make a good case for an establishment of R.E. Units that are designed to deal with the urgent temporary requirements that are certain to arise, and to make sure that such units have suitable tasks both at home and abroad earmarked for them.

The only units suited by their trade structure and equipment to build accommodation quickly are construction regiments, supported by plant regiments; at present we dispose of neither, so that when a real engineer requirement arises, as in Christmas Island, we have to milk all the Field Engineer Units of the Corps to improvise them.

If manpower is limited, then surely it is best to use some of it on units that are strong in trades and strong in plant, in other words to have Construction Regiments in place of Corps Engineer Regiments, and at the expense of some of the attachments, particularly those to the Works organization.

Such units may well be expensive to pay and equip, but they will not be expensive viewed over-all, since their work is productive; they will provide a means of attracting potential tradesmen into the Corps, since it will be possible to make an honest promise of employment in a trade, as well as training for a trade; they will give officers and N.C.Os. real responsibility for the planning and execution of projects, which they cannot get from attachments.

To get a proper balance of home and overseas service, it is essential to find tasks for such Construction Regiments at home as well as abroad; many promising civil projects suggest themselves—motor ways, land reclamation, coast protection and so on, but all of these at present are ruled out by trades union and contractors' objections, which can only be overcome in slow time by political action at a very high level; meanwhile, however, there are possible tasks on War Dept. Land and within War Dept. powers—such as roads and hutted camps on training areas, or demolition and rehabilitation on abandoned War Dept. Land. These would guarantee worthwhile work for a Construction and a Plant Regiment for at least five years while the way was opened for other projects, and would not raise objections from trades unions.

Abroad, there is invariably a temporary accommodation crisis in some theatre or other and often in several at once; the Civilian Works Service would undoubtedly be vastly relieved to have the worst "black spots" taken from them, even if the more spectacular requirements such as a Cold War or a Christmas Island did not recur at once.

This work may not sound exciting but it has the great advantage of being needed by the Army and of being a true picture of what the Corps is required to do in war; done as an urgent requirement, and with a suitably flexible arrangement for the supply of funds and stores, it would be excellent training for engineers of all ranks.

Some attachments to consultants and contractors will still be necessary to broaden experience, but these will be more valuable and more popular if they can be so framed that officers have a real responsibility to produce results, as well as a duty to learn how things are done, and a chance of commanding Sappers in the process.

One way in which this might be done would be to offer small detachments of officers and O.Rs. to consultants or contractors as engineer recce or survey teams; at the initial report stage and after, designing engineers need information from the site and need it quickly; the getting of this data often involves not only survey and measurement, but borings, soil samples, the gauging of water supplies and so on, all of which, in an undeveloped country, entails a minor expedition in itself—not an easy thing for consultants to lay on, but an ideal job for a small R.E. detachment that could give a large number of young officers invaluable experience of a small independent command, as well as a good bird's eye view of the problems involved in large works.

In this way, the Corps might provide a contribution to consultants that would indirectly benefit the contracting organization of the country by ensuring that British consultants were the first in the field with reports, based on reliable information.

If the Corps in the new Regular Army cannot produce the opportunities for real engineer experience, the senior regular Sapper of the future will have no place behind Division or even Brigade; his job will be taken by the professional engineers of the Reserve Army, who will have far less to learn about soldiering than the Regular Sapper has about engineering.

Yours faithfully,
W. F. ANDERSON, Brigadier.

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c/o Sir Robert McAlpine & Sons, Ltd.,
Bradwell Power Station,
Bradwell-on-Sea, Southminster,
Essex.
6th January, 1959.

The Editor,
Royal Engineers Journal

Dear Sir,

Brigadier Brown's article gives us the blunt choice between training the Corps as a whole to be better Engineers or of letting ourselves become Pioneers. The change to an all regular Corps gives us a chance to improve our standards of training of men and of units. This letter discusses the kind of engineers we want to be and how we may achieve this. It is largely from the Civil and not from the E. and M. point of view.

I read the lessons of the past to be:—

In 1914–18 and 39–45, the Corps produced enough senior Sappers who could both advise a Force Commander and make good use of the large intakes of expert engineers who were not, at first, trained soldiers.

In small wars, we have had enough specialists of our own for the work in hand.

We have now, except in Survey, lost all the specialist executive appointments we used to hold in Indian and Colonial Railways, P.W.D., Ports, etc.

Civilian Engineering has become much more complex and specialized in technique, design, and organization.

For nearly twenty years—at least half an officer generation—*regular* officers have had very little training in R.E. Works Services, which have been manned at officer level for the most part by Short Service and Emergency Commissioned officers and by civilians.

We are seriously worried if we are good enough to achieve our war role next time.

Since the war, National Service has made the training of the Corps difficult. In training, we have had to run very fast, like Alice, to keep in the same place. For real engineering on L. of C., we have assumed that A.E.R. would give birth to skilled construction regiments on mobilization which would tide us over until we could expand Works Services and organize L. of C. Works by Contract. In the all regular Corps, let us hope we stick to Regimental or Squadron trooping so that we keep our teamwork up. We should then have more time to take training beyond equipment, field and elementary engineering.

Since the war, training and staff have reduced the numbers of junior and middle-piece regular officers available and the time they are available for Works or Regimental appointments. Regiments have done little training in civil engineering. So we have had the anomaly of officers getting a thorough engineering education and practicing little of it.

Our programme of *training* specialists has been good, but training is no substitute for *executive* experience. Only the O.R.s of E.E.S. have had ample executive experience after their training.

Brigadier Brown lays much stress on the value of design to the training of the whole engineer. So do the civilian engineering institutions but it must be remembered that A.M.I.C.E., for instance, can be taken as young as 26 and is perhaps the equivalent of our promotion exam to major. After this stage, many senior, experienced,

skilful and highly regarded Civil Engineers—I cannot speak for electrical or mechanical—do little design. A large proportion of the profession is concerned with problems of construction in the field of permanent or temporary works, to head office design. Some partners in firms of Consulting engineers rise from site staff and some from the design office. Consultants' partners and their senior executives are concerned with controlling designers, controlling site staffs, administering work in progress and planning new projects. Among Civil engineering contractors, many firms do not insist on their agents being Chartered Civil Engineers, and have few qualified engineers on the board. A normal Contractors' site organization is that a Chief Engineer, with a staff of qualified and learner engineers, is responsible for advising the Agent on the engineering problems of doing the work. The Agent runs the job acting through Sub-Agents and Foreman: all are highly experienced construction engineers but in many firms (not all) they are not professionally qualified. This is a possible shape for the future of the Corps. We used this very organization at Christmas Island where a specialist team and R.H.Q., helped keep the engineering right.

It is true that the junior Sapper Officer has not, for a very long time been sufficiently drawing-board minded. This is because he is seldom made to work at a design on a board. Even contractors site engineers are seldom far from a drawing board and use it for quite minor temporary works.

Design is an important part of a senior engineer's background but it is only background. Given the opportunity some Sappers would become expert designers but the real field for the Corps is to be experts in field engineering and in construction. It amounts to the full and efficient use of Sapper equipment and of the common items of project plant. Regimental officers and N.C.O.s must be experts at using their men and equipment, assisted as needed by specialist officers, N.C.O.s and tradesmen. At the moment and because of post-war conditions, we cannot claim to be more than experts in Field Engineering, and in only a fairly narrow sense. (For instance, in an unusual demolition problem, one would ask advice from I.C.I. and not from the F.E. School).

Let us hope that Regiments or Squadrons can spend one year in three employed on real engineering works. In this year specialist teams must be attached to help train all ranks: regimental personnel should prepare formally all the designs of temporary works, minor site design and detailing, bar-bending schedules, quantities, estimates and programmes under the supervision of specialists. In the years between real engineering employment, any minor jobs like erecting the Totem Pole in Windsor Great Park should be fitted in wherever possible. I stress the importance of this minor design to every Sapper officer, particularly as he will have a chance to see his design built.

We must not underrate the value of field and equipment engineering particularly if they include (as they should) the use of plant. One major problem of any construction engineer is to get the men, plant and materials on to the job in the right order, in the right quantities and at the right time and place. The other is to make sure that he and his men know what to do with the plant and materials and do it right. Field engineering is good training in this. If to Field Engineering, we can add regular experience in Works projects of all types, we shall have a well trained Corps out of which it is easy to find and train all the specialists we need. The difficulty we now have in filling Clerks of Works Courses is symptomatic of the one sided-training we now do in Regiments.

Another deduction from this is that I lay no stress on the value to *every* Sapper officer of B.Sc. (Engineering). The officer who can only achieve an honours degree by a miracle of hardwork, might use the time better by getting more practical experience in a Regiment, provided that its training is broad enough in scope.

Specialist Training

Since the war, we have put the training of Specialist Engineers on to a sound basis with the long courses for officers and of O.R.s of E. for E.S. The number we require

and can spare for such training needs to be recalculated. These courses are no substitute for executive experience. In particular, officers on Long Engineering courses are unlikely to get executive experience at the same level of responsibility as their rank in the Corps. By the time they know enough to earn promotion with their civilian employers, their attachment is liable to be nearly over. If, of course, Regiments do more engineering work, the standard of our officers going on courses may rise. Even so promotion in civilian life is a matter of opportunity and personality and proved performance: a firm cannot afford to let an attached officer learn from his mistakes.

The way of giving specialists the experience to consolidate their training is both in regimental engineering works and by secondments *for a full tour of duty* with a civilian employer. Can we persuade consulting engineers, the civilianized works service, Colonial P.W.D.s, Port and Harbour Authorities in U.K. and overseas, for instance, to carry and pay a few officers and O.R.s on secondment who will be relieved by others with similar training every two or three years? If so, the loss of Works Services may be a blessing in disguise. For it may broaden the experience of our specialists.

R.E. Works Services have been of great value to the Corps in providing good training for O.R.s and in training officers in the planning and running of building projects, of which the principles are not very different from Civil engineering. However, it is rather narrow training in that it seldom includes heavy civil engineering work of the type we may have to do in war and that it does not normally include work by Directly Employed Labour, i.e. the Contractors' problem. Modern war may well require that more work is done by D.E.L. or by troops supported by civilian labour.

For the training of Directors of Works and Chief Engineers L. of C. in war, we are thrown back on the old plan of almost permanent secondments. But we must beware of Kipling's comments on professional qualifications in the Indian Railways Department when "Only a Sapper from Chatham can manage the Railways of State". Can we find a firm or department that will block the promotion of its own cadre by taking senior Sappers on secondment? It might be possible in a country like Ghana which is manning its P.W.D. largely by engineers on short-term contracts until its own young engineers are experienced enough to take over. Or must we rely on recalling from reserve, Sappers who have retired and reached senior rank in the civilian engineering industry?

Postscripts

I welcome a closer integration between E. for E.S. and Regimental W.Os. and N.C.Os. which must surely follow if specialist teams work regularly in Regiments. Some W.O.I. Clerks of Works have the personality and all the attributes of a first-class R.S.M. The training and responsibility sharpens their wits and character.

Quantity Surveyors. We shall need them in the Corps in War. In my opinion A.R.I.C.S. could be just as good a background for C.E., L. of C., as B.Sc. A.M.I.C.E. Can we persuade any younger quantity Surveyors to change their terms of service and to alternate between regimental and technical employment? Would this reduce their market value on retirement or would wider experience enhance it?

Technical Q.M. It is to be hoped that we shall not lose the outlet of E. for E.S. personnel to commissions. I would add my recommendation that selection should be made younger, that officers promoted should do a course after selection and that they should be eligible for regimental as well as technical employment and promotion.

Unit Strengths. If manpower is short, let us keep a limited number of Regiments and Squadrons at full strength rather than all at Cadre strength.

A.M.I.R.E.? Do not let us delude ourselves that putting alphabetical qualifications after our names will increase our professional status, however carefully the tests are framed and carried out. Our status will depend on the kind of work we do and on the skill, knowledge and personality of the officers and O.R.s whom we send on attachments to civilian engineers. If we can present worthwhile papers at meetings of the Institution of R.E., this would be a useful way of increasing our contacts with

civilian engineers whom we should invite to attend. There is some very good stuff in the Long Engineering Course thesis which is completely lost to the Corps in general. Equally we should encourage our specialists to present papers to the Civilian Institutions. To prepare a paper and even to take useful part in the discussion, takes time. What we really need is more time for individual officer training away from the grind of daily administration: we work too hard at routine and too little on training ourselves—particularly training as engineers.

Conclusion

The Corps is at the cross-roads to being more technical or less. If we do not want to become Pioneers, we must raise the general technical standard of all ranks by regularly employing Regiments on engineering works. The aim should be that the main body of the Corps is filled with sound practical general construction engineers. These must be supported by a group (the larger the better) of specialists in civilian engineering, a minority of whom will be designers, and (of course) by staff specialists in R.E. employ. The post-war revolution in the training of officer specialists is already making the engineering side of the Corps more attractive vis-a-vis staff. The all regular Corps and the loss of Works Services gives us the chance of avoiding the road to Pioneer Status.

Yours faithfully,
A. P. Smith, Colonel.

Headquarters, South-West District,
Sherford Camp, Taunton.
18th December, 1958.

The Editor.
Royal Engineers Journal

Dear Sir,

May I make the following points in support of Brigadier Brown's excellent article in the December *Journal*.

Necessity for Trained Engineers. The following and many similar tasks confront the R.E. officers of Divisional Engineers as well as elsewhere from time to time. With a good engineer background, even though for lack of practice he may have forgotten the mysteries of the calculus, he can have a sensible shot at these problems. Without that background training he would be a danger:—

(*a*) Intelligent use of equipment such as bridging equipment and, more important, intelligent misuse of it.

(*b*) The use of improvisation and local materials.

(*c*) Assessment of the strength of a damaged bridge and design of repair work.

Civil Engineer Specialists. To attempt to maintain all R.E. officers as Civil Engineers is to aim too high. We must resort to specialists within the Corps, and, just as we expect E. & M. officers with long E. & M. courses and A.M.I.Mech.E. and A.I.M.E.E., so Civil Engineer officers with long Civil Engineering Courses and A.M.I.C.E. must be regarded as specialists. The essential thing is that the specialist R.E. officers—Civil Engineers must be practiced as well as trained. This is not without precedent as for instance the career of a Staff Officer subsequent to his achievement of his p.s.c. All these experts (Civil, Electrical and Mechanical) must be employed throughout their careers in their specialist rôle alternating with postings to Regimental duty.

It would be excellent to stimulate interest in Civil Engineering through the *R.E. Journal* by means of technical papers. Whether anything would be achieved by inaugurating a qualification of A.M.I.R.E. which is not already signified by R.E. is doubtful. I feel that it is better for an officer who is so inclined to go for one of the Civilian qualifications which do exist and are well established and recognized the world over.

Individual Training. For the purpose of exercising all ranks in their trades, in building construction and minor organizations, the minor "works" job is invaluable. There must be many small new services in "works" which are suitable for a troop or Squadron to carry out complete during the four winter months of individual training. This is an excellent form of training which gives tradesmen practice at their trades, and exercises N.C.Os. and their officers in organizing a job, survey, laying out, quantities, stores ordering and technicalities. Incidentally it provides a cheaper building. Objections to this sort of job are mainly difficulties over "absenteeism" due to leave, fatigues etc., and the difficulty of clearing up if the job is not complete by the Unit in the allotted training period. This should be not insuperable.

Major Projects. Of course the ideal training for all ranks would be the major Civilian Engineer Project such as part of the Road Programme, using specialist A.M.I.C.E. officers as Consultants and Regiment as Contractors, this would be most valuable training for all ranks engaged in it. In particular road or air-field work would be valuable as these, though such a large proportion of R.E. operational tasks, occupy such a small proportion of normal training. The taking over of this project would however involve overcoming all possible Trade Union objections and would necessitate making available at least one Regiment (which could of course be relieved from time to time) for a prolonged period.

Military Engineering in war differs primarily from the Civil Engineering in peace in that the Civil Engineer faced with a technical problem normally has time to make all possible tests and investigations to support his opinion. The Military Engineer may well have to make on the spot Engineer decisions based on the best information available at the moment. Good Engineer training and experience are essential if sound decisions are to be made in such circumstances.

Yours faithfully,
R. Y. WELD, Colonel.

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1 Training Regiment, R.E.,
Cove, Hants.
1st January, 1959.

The Editor,
Royal Engineers Journal

Dear Sir,

Let us all agree with Brigadier Brown's wish to see us more civil engineer minded. But don't let us forget our assets. These are:—

A high prestige in the Army based on our record of producing battle-worthy units and good staff officers at all levels in the Army hierarchy.

Our reputation as field engineers.

Our reputation for offering more variety and opportunities both during and (in theory) after an active career.

It goes without saying that our past reputation as Civil Engineers, during war at any rate, stands high too. But it is that which is now in question.

I would suggest that we have maintained these assets because we have attracted a good share of talented officers, whose professional skill has by no means been related necessarily to engineering. We have attracted these officers, in my opinion, because it was more difficult to get into the Corps than into other branches, because a first-rate education was offered and because of the variety of opportunity mentioned above. It is more important to maintain this lion's share of talent than anything else.

If there is a danger that a satisfactory proportion of the most able of those who are joining the Army are not being attracted to the Corps, then we must look to it. There is nothing original in suggesting that, but expediency in searching for numbers by reducing standards is unlikely to pay off. Other ways of recruiting officers may be necessary. An imaginative short service scheme, more promotion of younger warrant officers and units accepting underposting more readily, are possiblities.

The most encouraging suggestion heard to date is that no officer should be accepted for a regular Commission who, when offered the opportunity as he should be later, cannot reasonably be expected to get to the staff college or to get an A.M.I.C.E. (or equivalent). Although Brigadier Brown has offered many good suggestions for improving our Civil Engineering skill, it is possible that they may not add up to a great deal (although it is reasonable to suppose that the General Tickells' of the future will anyway get sufficient training by these ways) and that it is to industry we must look for the bulk of our individual civil engineering experience. The good will and close co-operation of industry will be needed if many officers are to get their A.M.I.C.E. The A.M.I.C.E. idea could lead to even more advantageous schemes later and add greatly to the attraction of the Corps.

I agree with Brigadier Brown's implication that a "field engineer" rating may mean much or nothing and that too much stress can be put on it. However, with this accent on p.s.c. and A.M.I.C.E., there can and should be no let-up on field engineering. With an all Regular Army this does not mean spending more time on "pioneer and equipment" training. Far from it. But it does mean taking an intense interest in field engineering and having engineering and not *pioneer-minded* units producing very many more ideas on better ways of combat support than they do at the moment.

Throughout the Corps engineer officers and tradesmen soldiers must take field engineering in their stride.

Space forbids mentioning the other ranks aspects. The employment of tradesmen during winter trades training is perhaps the most promising line.

Yours faithfully,

M. L. CROSTHWAIT, Lieut.-Colonel, R.E.

Fortress Engineer Regiment,
South Barracks,
Gibraltar.
16th December, 1958.

The Editor,
Royal Engineers Journal

Dear Sir,

Although on the first page of his thought provoking article "Whither the Corps" Brigadier Brown has rightly bracketed electrical and mechanical engineering with civil and structural engineering, this aspect of the Corps' activities did not receive adequate attention in the discussion at the Engineer-in-Chief's conference. It cannot be too strongly emphasized that the electrical and mechanical engineer has a vital part to play in every large engineering project.

In the Establishment for Engineer Services, the Corps now possesses an invaluable reserve of skilled and experienced E. & M. manpower. This must at all costs be preserved and sustained by annual transfusions of fresh blood from Clerks of Works Courses.

Should we attempt to plan large projects without due regard to electrical and mechanical considerations and to execute them without trained E. & M. staff, then in the prophetic words of Marshal Bazaine before Sedan "Nous marchons à une désastre".

Yours faithfully,

R. A. LINDSELL, Lieut.-Colonel, R.E.

35 Corps Engineer Regiment,
Roberts Barracks, B.F.P.O. 36.
31st December, 1958.

The Editor,
Royal Engineers Journal

Dear Sir,

There is considerable truth in Brigadier Brown's contention that there is a cleavage between the field Sapper and the works Sapper and many will not regret the passing of Works Services. Views on the direction that the Corps must now take will depend on the officers' prejudices; perhaps it may disarm criticism if I state the origins of my own.

Background. As a Subaltern in Divisional Engineers in 1940–43, I saw eight regular officers senior to myself come and, often, go. Those whose backgrounds had been primarily works or searchlights very often did not survive the tempo of wartime training and operations. Their faults seemed to be: poor man-management, unwillingness to take responsibility and reluctance to learn the techniques—simple enough in those days—of field Sappers. My first prejudice is, therefore, that sharp-end Sappers in war must have had regimental experience in peace.

Next, later and in Italy; all field Sappers had to build special Bailey bridges; reinforced, on piers and as continuous spans—while we only had data on simple spans. When the pamphlets did arrive they confirmed our interpretation of Clapeyron in the field. Practical results had, of course, already done so. Clearly my second prejudice is that a high proportion of field Sappers must be engineers.

Third, the original Montebello expedition: we had magnificent experience in drawing up specifications in conjunction with the users, scientists and R.N., then of designing the structures to entirely new criteria and finally, of building them ourselves in difficult circumstances. This is exactly what Brigadier Brown advocates, and it is realistic Sapper training for war such as can never be practised on exercises. My third conviction is that all R.E. officers should do some real sappering of this nature as a normal part of their career.

Next, eighteen months as a D.C.R.E. showed me that for the most part conventional works services as practised recently, although fascinating, bears little resemblance either to engineering or to war.

Finally, three years in a Corps Engineer Regiment convinced me of two things; that early rather than late service in a unit is essential and secondly, that in peacetime it takes considerable time and effort to convert a unit from one rôle to another.

Professional Skill. Brigadier Brown implies that professional skill is skill at civil engineering, but we are military engineers not Civil Engineers. We must co-operate with other arms and provide the army with engineer support—this is very different from " . . . engineer services of various kinds including advice . . ."

We must therefore examine what is meant by professional skill in the various circumstances in which we will be required to exercise it.

There will be very little opportunity for civil engineering in the early stages of global nuclear war. We maintain forces trained for this war including brigaded field Squadrons practised in the most intimate co-operation with other arms. It is these Sappers which the rest of the army sees and their standard must be of the highest. They are judged primarily as soldiers. Their rôle is to provide timely field engineering within the framework of a commander's plan. The art of doing this must be kept continually polished. There will be no time to refurbish the technique after the outbreak of war. For these reasons I cannot believe that divisional engineers can devote one year in three to Civil Engineering. Also, I cannot agree that the minimum of of engineer knowledge is required in these squadrons. Occasional unforeseen problems will arise which only an officer with a good engineering education can solve—fast.

In cold and limited war there is a considerable requirement for Civil Engineering both by Regiments and by Brigade Field Squadrons to a lesser degree. We cannot rely on the reserve army to provide the necessary technical skill. A high proportion of regular officers must therefore receive sufficient engineering education to take on the types of task encountered in Korea, Port Said, and Cyprus.

There is not, however, a requirement for serious E. & M. construction warranting numbers of highly trained specialists. Oil storage and delivery, it is true, is a vital task but the genuine E. & M. content of this is small; water supply is unlikely to be undertaken at a scale greater than that of field engineering. There is often a need to repair or take over and run a civil installation, but only a few skilled men are required for the machinery, generating plant or pumps and the rest is basic engineering knowledge such as all Sapper officers should possess.

Specialization. Civilian engineering has become very specialized. One cannot expect a Sapper officer to be as expert in a particular subject as his civilian counterpart who devotes his whole life to it. However, we can narrow the field and simplify the problem: is it not time that we gave up studying building construction, which the civilian can carry out more satisfactorily; also E. & M. in the strict sense for which R.E.M.E. exists? We should be trained as civil engineers and battle engineers only.

The policy would be reflected in an altered other rank trade structure and different trade tests: we would require fewer electricians, joiners, painters, bricklayers and plumbers while needing more carpenters, steel erectors, pipe fitters plant and crane operators—which is a better balance for war.

Training. Training in battle engineering can be achieved by keeping the brigade squadrons continually at it and in civil engineering by finding suitable tasks for the Corps troops and non-brigaded squadrons. It must be a normal part of every Sapper officer's career to participate in the latter. There is not time for full degree-course officers to fit in a tour in both types of unit before Staff College age, so if an officer has served in one kind of squadron before his post-graduate course—whatever it may be—he should serve in the other type afterwards.

It would be a mistake to concentrate civil engineer training in specialist units with no operational rôle: there would be a large annual turnover and inevitably they would divide themselves into "permanent-staff" and "trainees". Men should, of course, do basic and upgrading trade courses as at present, but the best way to produce a field unit capable of taking on civil engineering tasks is for the unit itself to do them, with all the advantages to be gained of employing an organization and unit spirit already in being. It is also the best way to bowl out the "paper" tradesman and his officer equivalent. Furthermore, the order of battle and manpower cover probably do not require nor permit of the necessary numbers of construction squadrons.

I believe that a regiment is too large an organization to take on a civil engineering task with profit to all. Furthermore, there would be a tendency to concentrate the designing and planning in the hands of a few experts in R.H.Q. I believe that the best value would be obtained from one year's squadron tasks. The squadron would be run down to cadre during the planning phase and built up with the necessary tradesmen when construction began. By this I do not imply a complete change of all ranks. This is the opportunity to send men on higher trades training courses with the added advantage that they would be practising their trades later in the year. The M.T. and Q.staffs would have plenty to do handing in or preserving their operational equipment and drawing their works equipment. While Records would undoubtedly take the opportunity of posting out some men at the end of their second field engineer year, the postings of officers and senior N.C.O.s would inevitably still be on random dates as their tours were up and they were wanted elsewhere. During this planning phase the C.O. would probably arrange that the sergeants did their turn in regimental employments such as provost sergeant, or mess steward in the officers' or sergeants' messes.

The squadron should be excused during the year from desirable but not vital military distractions such as administrative inspections, range classification, wireless exercises, practicing the hot war operational task and regimental and formation details of all sorts. It would probably have to forego its Wednesday afternoon sports.

An officer or man posted to, say, a Corps Engineer Regiment would thus do two years at normal regimental duty as now understood and one year on a civil engineering task. At another period in his career he would serve in a Brigade Field Squadron.

The implication must be accepted that on any one day—including the day on which a war might break out—the regiment would find itself with one squadron well trained, one squadron on works and the third squadron recovering from the effect of having been on works for a year; however, all squadrons would have done at least a full year's training in both rôles within the last two to three years.

Finding the Jobs. Civil engineering required for nuclear tests is already with us. It is a great pity that the Corps, having got one foot in the door in 1951, is not now participating in construction for the use of all forms of nuclear power.

In Germany it appears possible to obtain minor civil engineering tasks without objection from the Trades Unions, particularly with Public Authorities such as the Canal Authority. Larger tasks could probably be negotiated even though there is unemployment, because these authorities are kept on a very tight budget and would welcome something for nothing. Elsewhere abroad similar considerations apply.

The real difficulty is in the U.K. The Civil Engineering Industry would, I believe, be amenable to persuasion. The Trades Unions should be carefully approached on a high level, pointing out how small the diversion of wages would be in practice. The contracting world already pays good wages to numbers of imported Southern Irish labour without protest from Labour in Great Britain. The principle should be established that the War Office (and possibly the Admiralty and Air Ministry as well) had the right to execute its own civil engineering by Sappers.

Jobs could be undertaken for which funds were not normally available in full. In this connexion the country needs hundreds of miles of motor-ways which involve many ideal Sapper tasks. We should sell the Minister of Transport the idea of building them by Sappers.

Chief Engineers of Commands and their staffs could supervise and maintain continuity—and here is training for higher engineer appointments. They should get their Commanders interested and ensure good publicity for the Corps.

Conclusions. Brigadier Brown underestimates the training necessary for Divisional engineers and they should not be employed on works. Nevertheless, the future rôle of the Corps does require a large proportion of officers with an engineering education and numbers of tradesmen. We should narrow the field to battle engineering and civil engineering in the strict sense.

It appears practicable to arrange that every officer should do one proper civil engineering job lasting a year in a non-divisional unit during his career (he may, of course, also specialize in this), and also do two to five years field engineer training.

The main difficulty is the Trades Unions in the U.K., who must be tackled at a high level.

Yours faithfully,
J. H. FRANKAU, Major, R.E.

Headquarters, E.S.E. (U.K.),
Kings Buildings, Dean Stanley Street,
London, S.W.1.
19th January, 1959.

The Editor,
Royal Engineers Journal

Dear Sir,

The article under the title "Whither the Corps" in the December, '58 issue of the *Journal* ventilated so well the problem the Corps faces in the future of producing efficient engineers.

It was obvious that something had to be done to improve the system under which the Corps were permitted to carry out Works Services. Many thought further civilianization would be tied to the recommended cure but it was not to be expected that the medicine would be so sharp that it would in the course of time weaken and seriously affect the efficiency of the Corps.

Brigadier Brown's article contains some excellent suggestions towards keeping our title of Engineers in the future and there are others that could be investigated. The means selected must however be complementary to and not conflict with the training for the prime tasks of our various units. Therefore, before the means of fitting in remedies to counteract the loss of "Works" are investigated, the existing training methods for individuals and units should be reviewed. Have we got the right type of units and are we satisfied that the existing system is the best to train Sappers for their tasks in the next war, or is our present organization accepted because it has been with us so long, and is the only one we know?

So we are faced with two basic questions:—

What is the best system and methods required for training Sappers of all ranks for their future tasks?

How can they be implemented?

The writer suggests that the issue is too big for expediency measures and that the medicine will have to be as drastic as the recommendations of the Weeks Committee, also they will have to carry equal weight to be accepted. It is thought that to convince the Army and the Treasury, outside recommendations will achieve more than recommendations from within the Corps. Perhaps the answer is a committee chaired by a General Officer and including an eminent civil engineer and most important of all a Treasury representative. We can learn from our friends, so it would be helpful if it could be made possible for members from the American and Dominion Engineers to be included.

If it is accepted that the organization and training of our units do not need revising, then we will have to add to the present system the means to make individuals more complete engineers. To this end, the following should be considered:—

(*a*) The formation of two construction battalions, one in U.K. the other overseas, to give an all in service of consultants and contractors.

(*b*) The Sappers attached to the new works organization be concentrated into two Chief Engineer Commands, thereby giving training to senior officers and incidentally preserving military discipline.

(*c*) Increased practical research and development by military staff at the S.M.E. (Compare in proportion our efforts with the American Engineers).

(*d*) Introduce all in engineering courses for N.C.Os. An elementary type for junior N.C.Os. and a little more advanced type for senior N.C.Os. Courses to consist of say:—Strength of materials, post and prestressed concrete, roads, drainage, plastics, electrical distribution, P.O.L. distribution, refrigeration, nuclear power.

(*e*) An increase of tradesmen and trade training particularly E. & M.

(*f*) Officers and N.C.Os. should be attached to a series of selected firms to study their products in order that Resources the Cinderella of the Corps is well served. The finest field units can achieve little without proper equipment and the Corps has the responsibility of supplying stores to the new works organization. Procurement (not stores accounting) requires people who can positively identify in detail a given range of items from the vast range of stores used by engineers.

Money and manpower for the above? During the last two wars the strength of the Corps was approximately 10 per cent of the Army, and for obvious reasons the percentage was reduced after hostilities. However, many doubt if our strength in 1963 and after will be a workable proportion. Anything the Corps gets extra means a cut somewhere else, therefore any apparent increase of our activities will meet the strongest opposition. Still we must be true to our salt and bring home to the proper quarter that a technically weak Corps of Engineers means a weak Army, therefore the position we find ourselves in today must be rectified for the good in the long run of the Country.

Yours faithfully,

H. R. Gower, Major, R.E.

E.T.C. & H.Q. A.E.R., R.E. (Field and Works),
Harper Barracks, Ripon.

The Editor,
Royal Engineers Journal

12th January, 1959.

Dear Sir,

The paper "Whither the Corps" is a clear exposition of the case for the Sapper to be an engineer first and a soldier second. It reaches its conclusions by examples from the past, and appreciations of the Corps in the present and future.

Its conclusions from the past seem open to doubt. While it is unwise completely to write-off the experience of the past, it is pertinent to note that the most recent example of past thinking in the paper, other than the Weeks Committee which belongs more properly to the present and future, is the Kitchener Committee in 1911. Lessons of organization and training, culled from the period preceding the 1914–18 War in which the nation as a whole was involved for the first time, are unlikely to have much validity in the future.

For the present, the Corps case for continuing to run Works Services must have been put as strongly as possible to the Weeks Committee, and was largely rejected. We should, therefore, examine our future as a Corps in the light of limited participation in Works Services, and of our rôle in future wars. The possibilities appear to be either Limited War or Global (Thermo-Nuclear) War, and it is difficult to see where large-scale projects can be of value in either of these cases.

One of the most depressing aspects of the current situation in the Corps is the low quality of our equipment, even by Army standards. Engineer Units are often unable to join fully in the training of their formations because of this inadequacy. Probably due to this, our influence on the policies of the Army has decreased. Symptomatic is the fact that the current F.E.M.W. on Field Defences appears to have gone completely unnoticed by the teeth arms and their commanders, in spite of its immense importance both to them and to us. It is worth noting that the Corps of Engineers in the United States Army, though technically extremely highly trained, has little influence on the policy of their Army as a whole, and may be said to have dropped to the position of a Service. In our own Army too, the purely technical arms have little influence on general policy, and moreover, seem to be finding it harder to recruit the men they need.

In the future, the provisions of the Weeks Committee are with us, and we must live with them. It does not appear that we are technically under strength for our future commitments. In the current Corps List, for example, one-third of the new officers are taking degree courses, and from these, sufficient officers speaking the "engineering language" should be produced. The danger, if we extend technical training too widely, is that the Corps will have nobody speaking the soldier's language, and will thereby lose its place in policy-making.

The Global War of the future is likely to be fought in two ways. The first "Soldiers' War" will be fought in Europe and farther afield by the overseas formations which are there at the time. It is there that our standards of training and equipment must be raised. The "Civilian War" will be fought in U.K. by the few troops here and by the Reserve Army and Civil Authorities. Their task will initially be that of survival, and subsequently of reconstruction, and it is from an efficient, home-based Reserve Army that the major military engineering effort must come.

We should, therefore, prepare somewhat differently for the future. Our first requirement should be to raise our Field Engineering to a standard at which "Field" tasks back to Army level can be carried out by Divisional and Corps Units. At the same time, we must insist on a standard of equipment at least equivalent to that of the Arms we support.

Our Civil Engineering experience should come from the officer who, as in Transportation, opts for special training after he has experience with troops. He may do a long course and one or more tours in a Civil Engineering capacity according to Corps requirements and his own aptitudes. The engineering experience for the war

at home must come from an efficient Reserve Army, whose terms of service in peace are adequate to keep it at reasonable strength.

Above all, we must not consider the Field Units, whose work with the fighting formations makes the Corps reputation, as poor relations. The proper task of the Sapper is to use his engineering skills to help the fighting formations win their battles. He should not regard himself as a Civil Engineer, with an incidental duty to fight when nothing better offers.

Yours faithfully,
R. G. Sfakianos, Major, R.E.

Resident Engineer,
Meeanee Barracks, Colchester.
12th January, 1959.

The Editor,
Royal Engineers Journal

Dear Sir,

Brigadier Brown's most enlightening and thoughtful article "Whither the Corps" prompts one, as an ex R.E. "Works Service type" to comment on the reasons leading up to the removal of Works Services from the Corps, as a result of the findings of the Weeks Committee.

I would suggest that in the main, the Corps has brought the situation upon itself, consequent upon a long chapter of events on which it is only possible to touch briefly in this letter.

I will not comment upon over-all Staff policy other than to say that it was a retrograde step to divorce Quartering from the Works Directorate. How often have the meagre purse strings been diverted to projects close to the heart of the "Q" officer rather than to the urgent needs of the Works officer! But it is also possible that the decline of the R.E. Works Services began after this decision, because the Works officer tended to lose contact with the rest of the Army and to become parochial.

An indication that the decline did in fact begin before the 1939-45 War, was reflected by the small number of R.E. officers, other than those of the appropriate Quartermaster classes, or those serving in India in Works, who shewed an active and lively interest in Works Services. There were exceptions, namely those who qualified at the E. & M. School, the few who were in the Works Directorate, and a handful of dedicated Engineers. The majority of R.E. officers treated "Works" as something to be avoided, or, when they were employed in Works, as a "jolly"—an opportunity for the pursuit of sporting and other extraneous activities leaving the job to the professional types—Garrison Engineers, I.R.E.Ms., Surveyors of Works, Clerks of Works, Mechanists, etc. This was well and good so long as the calibre of the professional grades remained at its pre-war level.

When the war came, almost 100 per cent of the pre-war Warrant Officers and N.C.Os. of the Establishment for Engineer Services, were commissioned. These officers formed the hard core of the Works Services throughout the War. They were tempered with an intake of County and Municipal Engineers, from whom they learnt a lot about good, sound practical engineering and the short circuiting of red tape, and qualified Clerks of Works and Foremen from civilian life. The Home Establishment proved a happy hunting ground for unqualified D.E.L. and many infiltrators, who took their chances and became established on the strength of the Civil Service in posts as Garrison Engineers and Clerks of Works. The standard was in consequence lowered.

Pre-war Regular Other Ranks who had held Emergency or Short Service Commissions, returned to find that the plums were held by these opportunists: they were confronted with the decision to "soldier on" or to revert to civil life at the bottom of the ladder, irrespective of their service or seniority. In many cases the jobs they had hoped to fulfil were held by their erstwhile Time-keepers now under the wing and

protection of the Civil Service. The fully qualified and highly efficient ex-Clerk of Works and Mechanists could only enter the field of Works Services as civilians in Technical Grade III (the lowest) appointments, and in the immediate post-war years were at the mercy of the many redundancies based upon the Civil Service dictum—"last in—first out". Alas! The Corps took it sitting down!

The immediate post-war output of Works Services personnel was poor, although there were notable exceptions. The entry standard was lowered, and the instructors in the Construction School were not of the right calibre. The results soon became apparent. The over-all standard of the Establishment for Engineer Services dropped, and the efficiency of the R.E. Works Service became impaired. No longer was a Superintending Clerk, R.E. the highly efficient and well versed Engineer Clerk that he was before the war, who could be relied upon to keep his superiors well informed and free from trouble, and his subordinates in mortal fear of his power and knowledge. No longer were Clerks of Works Sergeant Majors and Mechanist Warrant Officers, men of long service, seniority and experience, who could be relied upon to act upon their own judgement and who in many instances could act in superior appointments (G.E., I.R.E.M., etc), with ease, proud of their ability to qualify for an extra 1s. per day. The conscientious acceptance of the same responsibility was gone. The new Works Staff expected to be nursed largely by their superiors. To give an example, a normal area of responsibility for a pre-war Clerk of Works (Construction) was often two complete Barracks, the appropriate Married Quarters, and a Rifle Range, Sewage Works Installation, Water Works, etc., thrown in. He would also supervise all Part II Services within his area. He would do his own measuring, and would more often than not square his own dimensions and abstract them: he would maintain Painting Records, Barrack Accommodation Records, R.E. Inventories, and prepare detailed estimates for proposed new Part II or Maintenance Services. This meant, at times, the burning of much midnight oil, but he expected that. What was more, and most important, he made and found the time to study, in preparation for either the Chartered Surveyors Institution Examinations so that he might perhaps be commissioned as a Surveyor of Works before he was 35, or for his Promotion Examinations which he must take if he hoped to be promoted to Warrant Officer Class I, and later, to be commissioned as a Quartermaster (Garrison Engineer).

One does not have to stretch imagination far to consider how much of that load the present day Clerk of Works could accept and carry.

Why were not the Promotion Examinations resuscitated? Why did the Corps permit itself to be talked out of the direct entry to the Chartered Surveyors Institution by competitive examination of its Clerks of Works? At a guess, for every successful candidate commissioned as a Lieutenant (Surveyor of Works), R.E., there were twenty other candidates who passed the Intermediate Stage, and a further ten who attempted the Finals, all by good, hard studying, an excellent way of keeping the brain alert, and of being up-to-date in modern methods and procedures.

The post-war Works Service floundered. Its hard core was comprised of the pre-war Regulars now commissioned and serving as the "Middle-piece" officer: its Rank and File was inexperienced and in many cases unqualified to carry out the tasks expected of it. This Rank and File element was only kept alive by hard work by its officers and the bolstering effect given to it by a few qualified National Service Men serving in the capacity as Deputy Foremen of Works or as Draughtsmen. Clerks of Works, Constructional, Mechanical and Electrical were forced to spend most of their Service overseas. A lucky few were employed upon worthwhile new projects, but the majority were either with B.A.O.R. where they were not practised in their true rôle of being sole supervisors with full responsibility (the work being carried out by the German Authority), or in stations overseas carrying out maintenance upon Basha or similar local construction.

The senior appointments in Works Services fell, in the main, to the Regimental Officer who was forced to have a "Works" string to his bow, before he could become a Lieut.-Colonel or be considered as a Colonel. A fixed determination, based often on

social considerations, prevented the talented and tried-by-experience ranker Works officers from achieving one of these appointments,despite repeated recommendations. A select few, counted upon one hand, achieved Lieut.-Colonel (A.D.W. or C.R.E.) status. These had made their mark in the war and had attained the rank of War Substantive Major; it would have been difficult, in the face of their records and confidential reports, to revert them to the status of the middle-piece officer. Admittedly, by virtue of time promotion, many Short Service Officers achieved Field Rank, when it was found difficult to place them in appointments appropriate to their grade.

It may be thought that it is now too late to be constructive, but one has a feeling that in time the wheel will turn. The Royal Engineer Works Service will return, because it is difficult to see the new organization operating successfully in both Peace and War. The reaction will come from the General Staff and other Arms, just as it did when the Duke of Wellington decided that the Corps must be responsible for Works Services, perhaps even from the Treasury. The Corps must be prepared.

The selection of potential Establishment for Engineer Services personnel must be upon a more rigid and selective basis. Only the best are required.

The calibre of Instructors at the S.M.E. must be of the required high, and experienced standard.

Professional promotion examinations must be revived. There should be openings for Clerks of Works of all grades to be given opportunities for study and qualification, perhaps even to Degree standards.

The young officer should be grounded in "Works" for a minimum period long enough for him to assimilate the administrative and financial aspects, and for such a period as will enable his superiors to discover whether he is of Works "bent", in which case he should specialize with a view to obtaining a Degree before he reverts to other Corps requirements.

The fetish of sending the young officer to Cambridge to obtain his Degree should be redirected to sending him where he can obtain a more useful qualification, in civil engineering rather than mechanical.

The Works Service must be made fashionable: the incoming Sapper must be made to realize (*in full realization—not a pipe-dream*) that his slide-rule combined with character can lead him to the highest positions in the Army Works organization.

The Corps cannot afford to be snobbish over the matter, as it has been in the past. After all, it is the Works Services that need the qualified engineer, whilst, as Brigadier Brown suggests, a great deal of military engineering can be done by any intelligent infantryman or pioneer.

The Sapper tradesman getting special trades rates of pay, over and above the maximum he can receive as a Field Engineer, must be revived; only then can there be encouragement and the will to improve his real trade rating.

Test books need revision—there should be more of them. The rewriting of Regulations for Engineer Services was not very enlightened and it was not an acknowledged success. The Green Handbook (*Design and Construction of Military Buildings*) used to be a Bible for Works Services: it was out of date and discarded, but it could and should have been modernized upon the lines of its original conception.

Uninspired and light-hearted articles upon "This Works Services business" or "Teaching yourself to be a G.E.", which, from time to time have appeared in the *R.E. Journal*, and have been written by uninformed Regimental Officers who have been diverted from their Regiments to do a Works stint, have not assisted in any way to promote respect or maintain the prestige of "Works".

Yours faithfully,

M. E. MENAGE, Lieut.-Colonel, R.E. (Ret.).

"Nicobar",
Camden Park Road,
Chislehurst, Kent.
30th December, 1958.

The Editor,
Royal Engineers Journal

Dear Sir,

As one who resigned his commission because he wished to be a "real" engineer, I am naturally most interested in Brigadier Brown's article.

I entirely agree with the introductory quotation to the effect that the prestige of the Corps depends on the professional skill of its members, but do the Military and Corps Authorities want skilled military engineers? They certainly need them, as was demonstrated in the last war, but they have never in peace-time encouraged officers to concentrate on Engineering. In this century with the growth of scientific knowledge, it is impossible to have both a first-class soldier and a first-class engineer and the Corps will cease to attract the best types of young men until this is realized.

I doubt whether Works Services at home give much opportunity for the practice of Engineering though they do so abroad, unless too much of the Overseas planning and letting of contracts is carried out in the War Office by civilians.

I think Brigadier Brown concentrates too much on training, since training of any sort whether by attachment to contractors, or other methods, is not enough. An engineer must gain his experience by carrying the responsibility for actual engineering works, as U.S. engineers do and as the Royal Engineers have in the past—I refer particularly to irrigation and hydro-electric works in India and survey throughout the world.

While this letter deals particularly with officers, Brigadier Brown's remarks on the subject of tradesmen are equally sound.

The first need is, however, for the General Staff to demand that the Corps should consist of highly qualified engineers, and for the heads of the Corps to be convinced of it themselves.

Yours faithfully,
K. H. Tuson, Lieut.-Colonel, R.E. (Ret.).

The War Office (A.G.7),
Stanmore, Middlesex.
12th December, 1958.

The Editor,
Royal Engineers Journal.

Dear Sir,

TRADE TRAINING

I am prompted to write in response to Colonel Weld's letter in your December, 1958 issue of the *Journal*.

He makes two points:—

(*a*) We do not guarantee practice at all trades.

(*b*) Recruiting literature dishonestly implies that we do.

The "guaranteed trades employment scheme" guarantees employment at a trade without specifying any period per year at which the soldier should be so employed. We can only honestly state in recruiting literature that this scheme is open to very few trades, for example drivers and clerks.

This scheme is not to be confused with the "guaranteed trade training scheme".

No one would disagree that trades employment for all tradesmen is a good thing sometimes, though I think it an exaggeration to say that three or four months per year is essential.

One hopes that since Colonel Weld was a Subaltern many C.O.s have been able to find practical engineering tasks demanding trades skills in order to provide scope for trade employment. It would be impossible, I suggest, to guarantee that they could all do so every year and dishonest to say so.

If Colonel Weld would quote to A.G.7, any examples of dishonesty in recruiting literature I should be more than grateful. Although I do not write the literature myself I can see that it is amended where necessary. A dishonest innuendo in recruiting literature is, I agree, much to be deplored.

Yours faithfully,
B. S. Armitage, Colonel,
Assistant Adjutant General, R.E.

Book Reviews

EDITORIAL NOTES FROM "CONCRETE AND CONSTRUCTIONAL ENGINEERING"

By H. L. CHILDE

(Published by Concrete Publications Ltd. Price 7s. 6d.)

This slim volume of short editorial essays is a joy to read. Taken in small doses, its clear message should purge away much verbosity and muddled thinking. Each essay is a plea for simple sanity in a jargon-ridden world, and their contents may be simply summarized by listing some of the chapter headings: "A plea for the simple word": "British Standard Meanings": "The Education of an Engineer": "Design, Decoration and Utility": "Fitness for Purpose".

All Sapper Officers have to write reports from time to time, and also read reports. Much time would be saved if every written word was either "technical shorthand", precisely defined, or good, simple English, easily understood. Any writer who can find no value in this book is as arrogant as Humpty Dumpty, who claimed: "When *I* use a word it means just what I choose it to mean".

T.W.T.

OFFICIAL HISTORY OF THE SECOND WORLD WAR THE WAR AGAINST JAPAN

Volume II. India's Most Dangerous Hour

By MAJOR-GENERAL S. WOODBURN KIRBY

(Published by H.M.S.O. Price 55s.)

General Kirby has produced a first-rate narrative of the loss of Burma, and of the Pacific war from after Pearl Harbour until September 1943. He is an adept at sketching in the administrative and diplomatic backgrounds. There are also interesting accounts of the events in the Aleutians, and of the conquest of Madagascar, where the then Brigadier F. W. Festing commanded a brigade. The maps and sketches are a particularly good feature.

The Japanese threat had been badly underestimated by those best placed to know the secrets. It is safe to say that the Japanese government was not hindered by any internal opinion that there was nothing worse than war. A large number of the Emperor's subjects thought there was nothing better.

"*In August,* 1940, *the Chiefs of Staff reviewed the situation in the Far East and concluded that . . . the invasion of Burmese territory would still be a comparatively remote threat.*"—*Page* 11.

The Japanese forces who conquered Burma in 1942, though not numerically superior, were trained, experienced, eager to devour their opponents. The British and Indian forces were on the whole new to war, they were only partly trained, and their efforts were confined mainly to holding successive positions. The Japanese strategy, though not far-seeing, was rapid, and their tactics were alert and aggressive. The tactics of their opponents, on the other hand, perforce resembled, here and there, the movements of the now proverbial wet hen.

". . . *neither Burma Army nor Burcorps foresaw the speed with which the Japanese could reach Monywa once the 2nd Burma Brigade had left Pakokku . . . The loss of Monywa disrupted the whole plan of withdrawal . . .*"—*Page* 218.

The story of the fighting in Arakan in the dry season 1942–3 is almost too painful to read. In that campaign we touched bottom. It brought the military careers of Field Marshal Lord Wavell and several other commanders to an end.

Something new was wanted. Something to revive Hope. Perhaps it was little more than a change in nomenclature. Could it be that we should give more attention to Japanese morale?

"*Wingate . . . found himself almost overnight a national hero.*"—*Page* 327.

The Japanese found Wingate "difficult to deal with"; they received the news of his death "with jubilation". He had them chasing his shadow, and his superb nonchalance and pervasive power of destruction tipped the balance of morale in the East. Some civilian reviewers have drawn chief attention to his vanity, to his one military error, and to the apparent ineffectiveness of his action. They make the eternal civilian mistake of underestimating and belittling the principal factor in war.

"*A la guerre les trois quarts sont des affaires morales.*" Napoleon.

Wingate's gift to the battered generals was his much needed development of a new form of the military art.

In the Pacific the skill and toughness of the Americans, supported by Australian naval and land forces and by first-class Intelligence forecasts, gradually turned the scale in our favour. Long before the conquest of Germany the defeat of Japan was made certain by her inability to replace lost ships and aircraft as quickly as the nations she had attacked. The Allies had only to go on hammering at them, and the harder the better.

"*The President . . . likened the area held by the Japanese to a slice of pie with Japan at the apex and the island barrier formed by the Netherlands East Indies as the crust. He considered that the strategy of the Allies should be to advance as far along the two edges of the slice towards the apex as was necessary to enable them to bomb the Japanese mainland and shipping on the routes to the various points on the crust.*"—*Page* 422.

The Japanese were to have their slice of pie turned into a *bombe surprise.*

K.B.S.C.

MEN FIGHTING: BATTLE STORIES

Edited by JOHN NORTH

(Published by Faber & Faber. Price 18s.)

This book is an anthology of war stories relating to battles since Mons (1914) in which British soldiers have fought. If, however, you really want to know what war is like you must read something longer than a story. War is a long drawn out affair, a constant struggle in which you may perhaps relax occasionally, but always at the back of your mind is the certainty that the real thing will soon start again; and many of the books from which these stories are extracted give exactly that impression. Take for instance *Wings of the Wind*, written by a Sapper—Peter Stainforth of 1st Parachute Squadron. That book covers a good many months of fighting, and gives you an idea of the inexorable nature of war, and how the author and his companions fared in good times and bad. But the story here extracted and printed from it—*The Bridge*—makes it all seem a flash in the pan; and the reader turns over the page and finds himself in another battle in a different country. There is not much picture in this book of the endurance needed; the longest episode is a few weeks and many stories last only a few hours. Perhaps that is why the two Commando stories read so well. Both were short episodes in real life too.

Your reviewer was disappointed in not seeing some of Sassoon's writing. He had a belly-full of the real thing and can make his readers taste it. Some of these writers can do that too; but not all. *Crab and Lady Bird*, a story about two tank crews in 1916 and *Musical Box* a story of another tank crew in 1918 are mere compilations by a eulogistic officer from official records. The greatness of both occasions is lost in superlatives.

Having said that, it must be granted that most of the stories are extremely well written, and do give a glimpse of the moment in a well judged light. *Barrage*, by Private 19022 Frederic Manning is a powerful description of an attack in Picardy in 1916. You get an idea of how bloody it was, and how the men reacted. One forgets, however, that the offensive went on from July to November; and—unless you have inside knowledge—you do not know whether the poor devil who wrote it survived to the end.

In the Manner of the Brigade is a well written narrative, in a semi-humorous, cultured vein by civilian, turned soldier, who was wounded and captured at Mons; and *J'ai Perdu Mon Cheval* by Philip Gibbs is, as one would expect from his pen, a brilliant vignette; it describes a not very noble incident in a Base Area in 1916. *Lili Marlen* by a B.B.C. man recaptures the bewildered state of the Eighth Army at the time Tobruk fell in 1942; and *Coup de Partance*, an account of the Suez affair in 1956, makes one wonder why no one on the spot turned a blind eye to the order to halt at midnight. The same author also contributes a well written account of a battle in Korea, taken from his book *One Man's War*.

The Editor, in his preface, makes three claims for his choice. "The fighting man himself is speaking", he says; and "If the stories . . . place on record a background atmosphere, they have value"; and again, they belong "to the 'I was there' category". Your reviewer thinks these claims are not substantiated as well as they might have been. Some of the stories fulfil all three qualifications, but not all. They all could—and should—but they don't. That is what is wrong.

M.C.A.H.

LAGOS STEAM TRAMWAY (1902–1933)

By NEVIL MILLER

(Published by W. J. Fowler & Son, Ltd. Price 7s. 6d.)

Some abandoned lengths of rail on Lagos waterfront first aroused the curiosity of Major Miller. His subsequent inquiries unearthed the colourful story of a most unusual steam tramway, from its proud beginnings to its humble end, catering only for the lowest domestic services of the City.

In this attractive small book is traced the history of the tramway, illustrated with beautifully clear photographs and reproductions of engineering drawings. A detailed account is given of the operation and problems of the tramway and this is interspersed with lively descriptions of local life and people.

This is a book which will delight all railway enthusiasts as a record of the curious locomotives and carriages which have unfortunately been destroyed.

Major Miller has held a Commission in the Royal Engineers and is now in the Lagos Executive Development Board. A short foreword has been written by another Sapper, Colonel Sir Ralf Emerson, Kt., C.I.E., O.B.E., Chairman, Nigeria Railway Corporation.

C.H.B.

Technical Notes

Notes from *Civil Engineering* and *Public Works Review*, October, 1958.

A MODERN SELF ANCHORED SUSPENSION BRIDGE

The article describes the design and construction of a suspension bridge recently completed at Samawa, in Iraq. The description is interesting, and very generously illustrated by photos and drawings. A feature which might have a practical use in military bridging is the method of anchoring the suspension cables. The two cables each consist of 270 high tensile wires 0.276 in. diameter, galvanized for durability, and anchored off, at a specially designed end block, with Gifford-Udall wire anchorages.

PRACTICAL ASPECTS OF HIGH SPEED HARD ROCK TUNNELLING METHODS

This first part of a series of articles on modern tunnelling methods concentrates on the aspect of drilling. A very complete résumé is given of the various types of rock drill (percussive, rotary, rotary percussive) with a brief note of their advantages and shortcomings. The article continues with methods of supporting the drills, dust suppression methods, lubrication and air supply, and gives many valuable points to note in the positioning and use of these items of equipment.

Soil Sampling in Permafrost Areas

This short article highlights the difficulties encountered. Transport problems demand a light rig, while the material to be sampled requires considerable effort due to its rock-like properties. These properties need to be tested and recorded without the sample thawing out. Some of the methods of overcoming these problems are described, and may have a value for military engineers faced with working in this unusual field.

Tests of Efficiency of Joints to Precast Concrete Members

A series of tests were carried out in the Structural Engineering Laboratory at the Manchester College of Science and Technology. This first article of a series describes tests on three types of joint commonly used in joining up precast beams, tests on the joints of two sizes of portal frames, and two types of splice joint for columns.

The results indicate where failure may be expected; whether the continuation bars may slip, due to lack of bond; whether a failure may be due to the breakdown of welds; whether the joint is sensibly as strong as the rest of the members themselves. No practical design rules emerge from this first article, but it is possible that, in the articles to follow, some guide may be given when the conclusions are summarized.

Influence of Traction Force on the Design of Earth Channels

The author describes a simple method for the design of an earth channel which will avoid scour. He then develops this design (which may be ideal in theory, but uneconomic in practice) to show how a more practical design can be obtained by altering the shape of the channel, or its gradient, utilizing steps and stilling basins to absorb wave energy. Although a military engineer may usually design drainage channels by rule of thumb, and seldom calculates velocities, this article may be a useful reference.

Research on a New Doubly Curved Shell

This second article concludes the subject. It gives the method used for manufacturing the shell roof units, and describes tests carried out at Roorkee which indicate that these very simple roof panels are extremely strong and resistant even to shock loading.

The method of manufacture appears delightfully simple, and well within the capacity of a field unit requiring a roof. A square frame (4 × 4 ft.) is covered with hessian and placed over a masonry platform so that the cloth is supported. A 1-in. screed is placed and compacted over the hessian, composed of low-grade concrete. In India a lime-brickbat mix was successfully used. The mould is then lifted and supported at the four corners, so that the hessian sags, by self weight, much in the manner of the Ctesiphon Shed, but in this case doubly curved. An edge beam, lightly reinforced, is then cast, and the final result is a light, thin shell which has excellent properties as a roof panel.

The article does not give every detail which is required for a complete design to be made. It does, however, point the way to a method, which, by trial, and error, may prove very useful.

Notes from *Civil Engineering* and *Public Works Review*, November, 1958.

The Water Tower at Orebro, Sweden

The description of the water tower is of considerable interest. Although the construction of such a structure is unlikely to be the task of a military engineer, there are several points to note.

The outer walls are "fluted". This gives a pleasing architectural feature, and also provides anchor blocks for the prestressing cables. The upper structure, which weighs 3,200 tons, was cast from the ground, and was then jacked up about forty-five metres into the air by means of thirty-two jacks. In order to control the lifts, twenty-nine of the jacks were connected in series to one pump at a pressure just under that required

to lift the structure. The three jacks which actually created the final lifting force were each hand operated. This gave the effect of a three-point lift to an otherwise "floating" load, and permitted careful control to maintain exact levels. The lifting operation was checked for alignment, tilting and rotation from a central control board. Among the control devices were a pendulum plummet, levels and control lamps which were lighted or extinguished as the water level in communicating vessels on the roof went up or down a certain distance from a neutral point in the vessels.

Jacking Hangar Roofs into Position

This is a second example of a heavy structure being jacked up into position, in order to make its construction easy from ground level. The roof, a prestressed barrel vault, weighed 1,400 tons and was jacked up 46 ft. In this case the lifting was controlled by using walkie-talkie radios. A point of interest is that the prestressing cables in the 180 ft. beams were laid out full length and sheathed before the concrete was poured. This precaution was taken to avoid having to thread wires through such a very long duct. Prestressing was also controlled by walkie-talkie. It is also of interest to note that the thickness of the shell was only 3¼ in.—and contained five layers of reinforcement in some places.

Notes from *Civil Engineering and Public Works Review*, December, 1958.

Tax Relief on Professional Subscriptions

Associate Members of the Institution of Civil Engineers may be interested in the item on page 1371 which indicates that the annual subscription may be allowed as a deduction from emoluments assessable to income under Schedule E. This does not apply to subscriptions to the Institution of Royal Engineers.

Automatically Controlled Garage

Details are given of a car park for 1,320 cars built in Toronto. This four level subterranean garage spreads under 10 acres of Toronto's new civic square, and cost $3 million. There are 3½ miles of traffic ailes, and the attendants use scooters to get around the job.

Calculation of Critical Loads for Struts of Non-Uniform Section

It is sometimes necessary to estimate the critical load for a member, used as a strut, which is not of the same cross-section throughout its length. The author, Mr. A. Omerod, B.Sc., D.I.C., A.M.I.Mech.E., of the Royal Military College of Science, has produced a very simple and clear analysis of the problem. Instead of guessing a deflection curve, and considering strain energy equations, the general equations for BM and Shear Force for a strut are applied to the shape in question. Analysis of the boundary conditions helps to reduce the number of unknowns, leaving an equation which the author demonstrates can be solved by intelligent approximation to within the limits of preciseness required. The article illustrates a large variety of "end conditions", etc., which is a great help towards this "intelligent approximation".

Analysis of Continuous Beams on Elastic Supports

This article considers *one* of several analytical methods for solving this problem. It involves analysing all the possible happenings at the elastic support (bending of the beams; vertical displacement; twist) and deriving general equations for each support considered from the points of view of the beams supported thereon. There are several limiting conditions which can then be applied—principally of the type that action and reaction are equal and opposite, or that there is no BM at a free end.

The article is to be continued, and it is to be seen whether the author's simplifications of the standard formulae will result in a simplification of the final arithmetic —or whether the result is in a neatly packaged form ready for a computing machine.

THE INFLUENCE OF BOND ON THE FLEXURAL STRENGTH OF PRESTRESSED CONCRETE BEAMS

This first part of an article by Messrs Bennett and O'Keeffe describes the testing of forty sample beams with a view to checking on the recommendations of the new Draft Code of Practice for Prestressed Concrete. It is possible to design up to the limit of endurance by either the steel or the concrete, and to set a safety factor on these results, only if such limits can be passed by the one material to the other—i.e. by stress transfer by bond. It is certain that a higher bond develops round a number of HT wires in a cable than round an equivalent sized single HT bar. The tests described were designed to check the effects of varying the types of duct, grout, wire and bar. The authors concluded that the Draft Code of Practice for Prestressed Concrete is satisfactory for pretensioned and non-bonded work—but is over optimistic in allowing for post-tensioned, grouted beams. Further articles will undoubtedly produce the figures to recommend amendments to the Draft Code of Practice.

GROUTING AND INJECTION TECHNIQUES IN CIVIL ENGINEERING

This article forms a useful summary of many of the processes in use. As most processes are patented, and the secrets closely guarded, it is not surprising that practical details are frequently lacking. However, many more details of capabilities are given than are available in standard text books. T.W.T.

THE MILITARY ENGINEER

Journal of the Society of American Military Engineers

SEPTEMBER–OCTOBER, 1958

"Overseas Military Construction" and "Engineers in U.S.A.R.E.U.R."

These two articles are dealt with together because between them they give a picture of the role of the Engineers in the United States Army which is of special interest now that the Works Service in the British Army is passing to civilian control. The two articles follow one another and are amplified by two subsequent papers interesting from the same point of view, which give details of construction work in France and Pakistan.

Overseas Military Construction being carried out by the Corps of Engineers comprises bases for both Army and Air Force, and in some cases for the Navy, and for friendly governments in locations extending from Korea to Europe and from the Caribbean to the Arctic. The organization for this work is similar to that which has obtained in the United States. Under the Chief of Engineers there are three main divisions subdivided into districts; Mediterranean; CONUS—generally speaking the American continent and the Arctic, and the Pacific Ocean. In France and Germany there are Construction Agencies under the Commander-in-Chief with the Chief of Engineers exercising technical staff supervision.

The Engineer United States Army in Europe (U.S.A.R.E.U.R.) is responsible for construction of facilities required by the U.S. Army in France and Germany and for making the Lines of Communication fully operational. The Engineer units in U.S.A.R.E.U.R. are divided into three main organizations in accordance with the tasks for which they would be responsible in war time. The strength of the Engineers is given as approximately ten engineer combat battalions, with a balanced number of specialist companies, e.g., bridging, and twelve engineer construction battalions supported by specialist units such as a pipe line company, a port construction company and heavy equipment companies. In addition the Construction Agency arranges for work to be carried out by contract. Some idea of the scale of operation is given by the fact that the cost of the military construction Army programme in 1957 exceeded $300,000,000.

It will be seen that the U.S. Army Engineers are deployed throughout the world in readiness for war and the responsibility for Engineer work is through Engineer

channels, directly in the case of the Construction Divisions, and on a technical and staff basis in the Commands in Europe. Moreover the importance of the contribution to war-readiness to be made by the Engineers is well understood and acted upon. Can we say that this is the case in the British Army? Have we enough construction units fully operational providing essential training and experience, and will the new Works Service, with the help of the serving officers and other ranks who will fill a certain number of posts, be able to maintain a similar standard of readiness for war or any other emergency?

NOVEMBER–DECEMBER, 1958

"Combat Engineers in the Field Army" by General Bruce C. Clarke, United States Army.

General Clarke in a vigorous condensed article gives a vivid impressionistic picture of the engineer tasks in the battle area in a major war of the future, using nuclear weapons, and gives broad, but clear indications of the technical and organizational means which should be developed and provided to meet them. He assumes that no appreciable increase in the numbers of engineers is to be expected and that reliance must be placed on machines of all kinds and armour. He also stresses the absolute necessity for continuous study of the engineer problems in war by the Staff and the Engineers in close co-operation. A truly thought provoking article.

"Preparation for the Engineer Role" by A. H. Davidson, jun., Colonel, Corps of Engineers.

Colonel Davidson gives an account of some of the projects on which the agencies of the Corps of Engineers responsible for examining the problems referred to by General Clarke are engaged. In particular he refers to the work of the Research and Development Laboratory and the Engineer School at Fort Belvoir.

There are interesting photographs but few technical details. Among the items described are infra-red equipments for night fighting and working and a giant earth augur capable of digging a hole 6 ft. in diameter and 22 ft. deep. Great interest is being taken in the development of amphibious units, which can move overland at high speed, and which can be coupled together by small detachments of men to make rafts for ferrying heavy equipment, while advanced thinking is taking place on novel bridging methods of different kinds. An indestructible roller for mine clearance is also referred to and an excellent photograph of it has been used for the frontispiece to the number.

"Wood with Reinforced Plastics" by Richard Mark.

Wood and reinforced plastics may be combined structurally in three ways:—

(*a*) In a structure designed in wood with reinforced plastic as a protective surface.

(*b*) In a structure designed in reinforced plastic with wood as a non-load-bearing spacing element for the reinforced plastic skin.

(*c*) In a structure designed so that each component bears a share of the load.

Experiments have shown that these composite materials are exceedingly durable, light, and relatively bullet proof in some cases. The article, after describing the experiments referred to above, gives examples of the ways in which these materials have been used, and suggests military uses to which they could be put. There are clear photographs, one in particular, of an assault boat with outboard motor carrying fifteen fully equipped soldiers.

"Industrial Preparedness and Defence" by Lewis J. Powell.

The present speed of development of technology has made industry and defence inter-dependent. Under these changing conditions new concepts for evaluating national preparedness must be developed.

This article describes some of the planning methods in use in the U.S. to ensure the most efficient way in which Industry can be employed in peace and expanded in war. The article is a little difficult to read but is an interesting contribution to a very important and complex subject.

"Britain's Nuclear Energy Development" by Fred. F. Kravath, Captain Civil Engineer Corps, United States Navy.

A comprehensive and appreciative account of the subject including a description of the organization and work of the U.K.A.E.A.

"New Military Methods and Devices" by John E. Quaile.

This is a short article with photographs of an infra-red device known as Long Path Infra Red (L.O.P.A.I.R.) An infra-red ray is reflected back from self aligning mirrors a quarter of mile away into a detector which analyses the beam, and can detect any contaminants crossing it even though they are colourless and invisible to the naked eye. The equipment, which is undergoing final tests, should provide a valuable device for keeping a look out against chemical warfare agents.

"The Pan-American Highway System" by Raymond L. Hill, Colonel, Corps of Engineers.

An account of the present position of the projected continuous motor-way linking North and South America from the U.S. to Argentina. Well worth reading, it makes our road problems in the U.K. seem very small beer.

"The Battle of Tannenburg" by Brigadier Sir Mark C. A. Henniker, C.B.E., D.S.O., M.C.

This is a very clear account of the battle which is of particular interest as it is written by a Sapper. It deals with the strategy of the battle at Army level and so does not touch on points specifically of Engineer interest, except for the fact that the German victory was made possible by the existence of a good railway system and its efficient use. J.S.W.S.

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, September, 1958

ST. LAWRENCE SEAWAY AND POWER PROJECT

This issue constitutes a progress report on the St. Lawrence Seaway, navigation on which is to be opened officially by H.M. The Queen in the spring of 1959.

A succinct review completes the historical record published in September, 1956 (see *R.E. Journal*, March, 1957), and is followed by seven papers on various engineering aspects of the project.

(a) Planning and Constructing the Lachine Section

This section, between Montreal Harbour and Lake St. Louis, is 18½ miles long, and has two locks giving a total lift of about fifty feet. Most of the problems were those commonly met in this type of construction, but the quantities involved were unusual, the over-all schedule of contracts was very tight, and the co-ordination of construction with the maintenance and modification of existing services necessitated meticulous planning.

(b) Soil and Foundation Problems

Problems concerning stable slopes, structural foundations, and water seepage are inherent in all canal work. The need for intensive investigation of subsurface conditions, both prior to design and throughout constructional operations, is clearly exemplified in this paper. Practical information is given about the design and construction of dykes, fill compaction and settlement, and groundwater control. Compaction by heavy loaded trucks is recommended over an irregular rock base and against sloping concrete walls.

(c) River Diversion by Rockfill Cofferdam

Of the numerous cofferdams used to harness the St. Lawrence River, the most spectacular was the rockfill Cofferdam "E", immediately upstream of Long Sault Rapids. This was required to divert the entire river flow of some 200,000 cfs., and

work was complicated by the swift current, and by the need to avoid interference with nearby navigation and power development. The planned scheme was modified in practice to suit the material readily available, and the experience gained in this unusual project is candidly recorded.

(d) St. Lawrence Power Project

Three short papers describe electrical features of the Canadian half of the joint powerhouse at the International Boundary, the transformer station associated with it, and the design of 230 kV transmission lines. The first two papers are concerned mainly with technical details of equipment, but the size of the installations leads to interesting features of control, maintenance, and protection. The transmission scheme is remarkable for the use of lighter towers than those previously employed. Their design is discussed in the third paper, which describes the types evolved and their associated equipment. The theoretical saving of over-all cost was about 25 per cent.

(e) Development of Great Lakes Harbours

This well presented review gives a clear picture of the potentialities and limitations of transportation through the new Seaway. Engineering and economic factors are convincingly outlined, and even a cursory study of this interesting paper will rationalize the reader's conception of the future of Canada's inland harbours.

Notes from *The Engineering Journal of Canada*, October, 1958.

Power—A Review of Recent Canadian Developments

The main paper in this issue reviews, Province by Province, the growth of power development in Canada during the last two or three years, and indicates the major power projects planned for the near future. It contains a wealth of encyclopaedic information and some interesting photographs.

Nuclear Power Development in Canada

The problem of large scale development of power from nuclear energy is of vital interest to most industrial countries. The general subject is clearly and briefly reviewed in this paper, which summarizes the divergencies in the development programmes of the United Kingdom, Western Europe (Euratom), Scandinavia, U.S.A., and the U.S.S.R., and describes in more detail the particular needs and economic factors governing Canadian planning. Basic nuclear processes and characteristics are described in plain language, and variations in design trends are simply explained.

Passamaquoddy Tidal Power Project

For many years men have dreamed of harnessing tides to provide useful power. Schemes for such development are being investigated in France, Argentina, and for our own River Severn, but the biggest project is that in the Bay of Fundy, lying between the provinces of Nova Scotia and New Brunswick.

At the south-western entrance of Fundy, Passamaquoddy Bay lies astride the international boundary between Canada and U.S.A., and investigations of the engineering aspects of the development project, and of the likely effects on the important fisheries in the area, are now being undertaken by boards set up by the International Joint Commission.

For the purposes of design, a two-pool scheme has been chosen, with a high-level pool separated from the sea by dams containing filling gates, a low-level pool with dams containing emptying gates, and a third dam, containing the power house, between the high and low-level pools. This arrangement provides continuous output of power, at a capacity varying between 100,000 and 375,000 kilowatts, and giving an estimated annual output of about 1,800 million kilowatt hours.

This interesting paper describes the projected design and the comprehensive survey of engineering and economic factors now in progress. Forty years of speculation

should be ended in the autumn of 1959, when the Joint Commission will be in a position to make recommendations, based on trustworthy data, to the Governments concerned.

Notes from *The Engineering Journal of Canada*, November, 1958.

This issue commemorates the centenary of the proclamation of British Columbia as a Crown Colony, and it contains eight short and interesting papers covering important aspects of the history and development of what soon became the sixth province of the Dominion of Canada. The first two papers include most generous appreciations of the work done between 1858 and 1863 by a detachment of Royal Engineers, 150 men under Colonel R. C. Moody, whose activities one author sums up as follows:—

"As surveyors, road and bridge builders, printers, town planners, et cetera, they performed work which, in later years, would be undertaken by several governmental departments."

Individual papers are:—

(*a*) *B.C.—An historical sketch*

An eminently readable account of early voyages of discovery and haphazard exploration, and of the firm and wise administration, by a handful of British, which led to the confederation of an isolated colony with the newly formed Dominion of Canada. Here is a splendid answer to biased charges levelled at "colonialism."

(*b*) *One hundred years of engineering*

A prize essay by an engineering student. The staggering achievements of the small R.E. detachment, within five years, are glowingly acclaimed, and subsequent development is trenchantly summarized.

(*c*) *Engineering B.C.'s forests*

An account of the development of the giant forest-industry of B.C., and of measures to ensure sustained yield and extraction from unexploited areas. Production over the last ten years is clearly summarized in some interesting tables.

(*d*) *The mineral industry and B.C.*

The discovery of gold, and the administrative problem created by the ensuing gold-rush, caused the establishment of the mainland colony and, eight years later, its consequences brought about amalgamation with the older colony of Vancouver Island. Gold founded the colony in 1858; in its centenary year the province was producing a dozen metals, nine industrial minerals, a dozen structural materials, and three fuels.

(*e*) *Highways in B.C.*

Compressed almost to encyclopaedic form, this paper conveys a vivid impression of the enormous road-building programme carried out since 1918. Even so, some routes are becoming congested, and new areas are still being developed. There will be scope for road engineers in B.C. for some time to come.

(*f*) *Planning—the key to future power development*

The author forecasts that B.C.'s requirements in electric power will rise from something over 2 million kilowatts in 1958, to nearly 50 million kilowatts in fifty years' time. Hydro, thermal (coal, oil, or gas), and nuclear power sources are briefly discussed, but the main conclusion is that integrated planning and control are vital, and that energy agreements must transcend political boundaries.

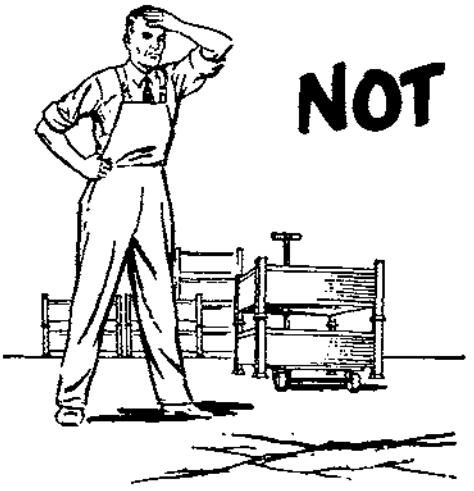
(*g*) *Industry*

An economic survey which includes some startling information and suggestions about labour problems.

(*h*) *Submarine power cable*

A brief account of the design and laying of specially constructed cable, to supply power from mainland sources to industrial centres on Vancouver Island.

P.P.A.D.L.



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