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'Spearfish' Exercise

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EDITORIAL NOTES

1. Spearfish Exercise

A PHOTOGRAPH is reproduced in this issue of the officers who attended the engineer exercise, called *Spearfish*, at Chatham on 21st, 22nd and 23rd July, and culminated with the E.-in-C.'s Conference in London on 24th July.

The party included representatives of the Dominion Engineers as well as the E.-in-C.'s and C.E.'s of most of the Overseas and Home Commands. Representatives of the Royal Navy, and Royal Air Force, the D.M.T. and other distinguished officers from the War Office and certain officers from Command H.Q.s also attended the exercise.

Space does not permit of giving the appointments of all the officers in the photograph. This detail has been restricted to those in the front row and to other officers not belonging to the Royal Engineers.

2. Royal Engineer Officers Who Held General Officer's Rank During the World War, 1939–45

A list of eighty R.E. Officers who held General's rank during the war was published in *The R.E. Journal* for June, 1947.

The following amendments regarding appointments have been brought to notice since publication :—

Lieut.-Gen. Sir Charles J. S. King.
Add C.E. Home Forces.

Maj.-Gen. J. S. Lethbridge.
Insert Director of Liaison and Munitions, W.O.

Maj.-Gen. P. J. Mackesy.
For " D.C.I.G.S." *substitute* " A.C.I.G.S."

Maj.-Gen. K. J. Martin
Delete " Comd. Worcs. Sub-Dist.", which was a Brigadier's appointment.

Lieut.-Gen. Sir Philip Neame.
Delete all appointments and *substitute* " D.C.G.S., B.E.F. ; Comd. 4 Ind. Div. Western Desert ; G.O.C. Palestine, Transjordan and Cyprus ; G.O.C.-in-C. and Military Governor, Cyrenaica Command ; and later Lieut.-Governor Guernsey."

Maj.-Gen. G. G. Waterhouse.
For " Comd. Mid-West Dist." *substitute* " Comd. North-West Dist."

Maj.-Gen. J. F. M. Whitely.
Insert D.C.G.S., A.F.H.Q.

Maj.-Gen. B. K. Young.
Insert M.G.R.E., A.F.H.Q.

The rank of " Maj.-Gen." R. G. W. H. Stone should be amended to read " Lieut.-Gen."

In a few cases appointments held after VJ Day were included in the list. These have not been amended.

3. Presentation of Silver Rose Bowl to the Officers of the Greek Engineers

The Silver Bowl, the photograph of which was reproduced in the *Journal* for March this year, was presented on 17th May, 1947, to the Engineer

Officers of the Greek Army at their S.M.E. situated on the north bank of the west entrance to the Corinth Canal. Before the presentation a Greek translation had been engraved on the opposite side of the bowl to the English inscription.

It had been hoped that the presentation would be made by the E.-in-C., M.E.L.F., Maj.-Gen. A. D. Campbell, but he was unable to come across from Egypt and Brigadier C. D. Steel, Deputy Commander of the British Military Mission to Greece, as senior Sapper in Greece, therefore deputized for him.

It had been originally planned that the presentation ceremony should take place, as the culminating feature of a Greek "Engineer Week," at a Guest Night to celebrate the opening of the new officers' mess, just being built for the school. Operations against the bandits led, however, to the postponement of the Engineer Week until the autumn, and trouble with a contractor delayed the completion of the mess.

An "Engineer Day" was held instead of the Week. It started with a general demonstration in the morning for Officers of all arms of the Greek National Army, showing the various activities of the Engineers, including demolitions, wet and dry and improvised bridging equipment, an assault crossing of the canal by recruits from the Basic Training Centre at Corinth, mine laying and lifting, road making and a general tour of the School. The demonstration was honoured by the presence of H.M. The King of the Hellenes, who is keenly interested in engineering, and was attended by about 150 Officers of the G.N.A., the Greek E.-in-C., Maj.-Gen. D. Karachristos, the Chief Engineers of B and C Army Corps and the Commandant of the Engineer Training Depot. The British Sapper Officers present were all agreed as to the excellence of the demonstration.

A representative party of Sapper Officers came down for the week-end consisting of Brigadier Steel, Colonel A. C. Shortt, Lieut.-Cols. W. G. Preston, F. M. Hill and W. H. Aylwin, Majors J. G. A. J. O'Ferrall, J. H. S. Bowring, R. A. S. Jenkins, W. E. Skinner and W. G. Beauchamp, Captains W. E. Betney, E. D. Smeeden and D. G. Chambers, Lieutenants J. A. McKay-Forbes and J. M. Plowman. Several wives also were present.

After the demonstration an R.E. lunch was held in the small R.E. Mess on the sea-shore, and in the afternoon, at the S.M.E. sports, the Senior Sapper Officers challenged the Greek Officers at Volley-Ball whilst the Junior Officers challenged them at Basket-Ball.

In the evening the Sapper Officers entertained the Senior Greek Officers and their wives at a small cocktail party in the mess before going on to dine with the Greek Officers at a Taverna overlooking the sea.

After the dinner Brigadier Steel made a short speech proposing the health of the Greek Engineers, the Rose Bowl was filled with Retzina, the National wine of Greece, passed round the R.E. Officers and finally presented—empty, of course—to the Greek E.-in-C. with musical honours. General Karachristos in thanking the Corps for the kind thought which had prompted the gift also took the opportunity to thank the Corps for all the help it had given to the Greek Engineers both during and after the war, and said that he hoped that this help and the friendship between the Greek and British Corps of Engineers would long continue. The bowl was then passed round the Greek Officers present to drink the health of the Corps and the party settled down to a series of English and Greek songs, finishing the evening with "The C.R.E." in a procession led by the Greek E.-in-C., who promised that they would try to produce a Greek version thereof.

WITH "WORKS" IN PAIFORCE

By Colonel R. E. Wood

Operational Background

THE Persia and Iraq Force (Paiforce) worked and had its being in two countries by no means strange to the British Army. No two countries side by side on the map could afford greater contrast. Iraq is mostly one vast alluvial plain, fertile where water can be carried and barren only by reason of lack of water, dependent for its life on two great rivers. Western Persia, except for the south-west province of Khuzistan, which is geographically part of the Iraq plain, is a high plateau 4,000–5,000 ft. above sea level, a country of wild mountain ranges interspersed with pleasant fertile valleys, where intense, if unintelligent, cultivation produces most of the country's needs. As one travels east the fertility and the mountains decrease until the great Salt Desert is reached stretching from the outskirts of Teheran to Baluchistan—perhaps one of the most forbidding and desolate regions on earth.

The contrast in climate is equally pronounced while a homely note of comparison is struck by the entire absence of potatoes in Iraq and their abundance in Persia.

It is not proposed to describe the general course of operations or the detailed stages of administrative planning during our occupation of these two countries. For purposes of this record it will be sufficient to divide the operations of four and a half years into four main phases.

Phase I (*May–October*, 1941)

Occupation of Iraq and Persia

This phase was chiefly operational and engineer work in the forward areas was generally a matter for Field units.

A Base organization was begun for the force then contemplated as necessary for the defence of the Iraq and South Persian Oilfields and the Persian Gulf Ports. The chief threat to their security then envisaged was the possibility of invasion through Turkey. The principal activity of the Works service was the installation of hospitals and the provision of water and such hot weather amenities as could be furnished. In Persia a boundary was fixed between the Russian and British zones, the line running south of the Elburz mountains.

Phase II (*October*, 1941–*July*, 1942)

Aid-to-Russia Planning

Development was begun of port facilities, communications and the administrative lay-out required to implement the programme of Aid-to-Russia. The initial target set was 100,000 tons monthly, and expansion was contemplated.

Five main routes were envisaged :—

(*A*) India–Zahidan–Meshed (rail to Zahidan and thence road).
(*B*) Bushire–Isfahan–Teheran (road).
(*C*) Bandar Shahpur–Ahwaz–Teheran–Bandar Shah (rail).
(*D*) Khorramshahr–Kazvin (part rail via route "C" and part road via Andimeshk–Khurramabad–Hamadan).
(*E*) Basra–Kut–Khanaqin–Hamadan–Takistan–Tabriz (river to Kut, thence rail to Khanaqin, thence road).

This obviously entailed a considerable road programme which included a two-year plan for a bitumen surface on routes " D " and " E." As far as docks were concerned additional deep water berths were required at Bandar Shahpur and Khorramshahr, including the provision of cranes, and electric power. Dock yards and jetties for I.W.T. barges were necessary at Basra and Kut. A considerable railway programme was needed in the port areas, at railheads, and for passing loops and sidings.

Routes " A," " B," and " C " were in operation by June, 1942.

Superimposed on the above was the development of our own Base areas for possible operations, defence and internal security schemes for North Iraq and West Persia. A further road commitment was the improvement of important strategical routes in Iraq.

Phase III (July, 1942–February, 1943)

Defence

The possibility had arisen of a German break-through from the Caucasus into North Persia. A large increase in troops and in the possible scale of operations became necessary. Defence lines were constructed covering main passes and other natural obstacles. Main and subsidiary demolition belts were prepared and arrangements drawn up for the immobilization of the oilfields, refineries and oil stocks in case of necessity.

The development of strategical roads, both forward and lateral, was put in hand bringing the total road mileage to over 7,000 miles.

The main Base at Shaiba was expanded and forward Bases built on both the Persian and Iraq L. of C.s. Advance Bases were also planned in North Persia and North Iraq. The danger was feared of air attacks on the Shatt-el-Arab ports and of the blocking of the Shatt from the sea (Japanese submarines were reported in the Persian Gulf during 1942). This was met by the start of quays and port facilities at Umm Qasr on the Persian Gulf 40 miles south of Basra.

Phase IV (February, 1943–March, 1945)

Aid-to-Russia in full operation

During Phase III consistent progress was made with the Aid-to-Russia Plans, many of the requirements being identical with those outlined above. In March, 1943, an adjustment of the Paiforce boundary with India took place as a result of which Route " A " became now the responsibility of North-West Army India.

From early 1942 onwards American troops (to be later known as the Persian Gulf Command [P.G.C.]) had begun to arrive—first of all the planning and recce parties, to be followed by railway troops and constructional engineers. By December, 1942, the P.G.C. had completed three out of six new berths at Khorramshahr docks and had taken over operation of the Persian Railway. American engineers constructed a new road from Khorramshahr to Andimeshk which was opened in the spring of 1943. Another of their activities was an aircraft assembly plant at Abadan.

By the middle of 1944 the peak of nearly 250,000 tons monthly was reaching Russia through Persia and Iraq.

Paiforce now become an important link in global strategy both as an east to west L. of C. and as a production area, especially for oil. A considerable programme of Works activities was required on airfields, accommodation, oil pipelines and filling plants. Iraq also served as a channel for Aid-to-Turkey.

Engineer Organization

The Engineer Organization required for these activities, did not necessarily change at the time a new phase opened but, for convenience in the summary which follows, changes in organization have been related to the phases with which they were connected.

Phase I

The Army of Occupation was an independent force originally under G.H.Q., India. It was styled British Troops in Iraq (or B.T.I.). C.E., B.T.I. had under him a small Works organization.

Phase II

The Force had now become the Tenth Army with the normal C.E.'s staff. To this was added a Maj.-Gen., R.E., with a Director of Works and staff. There were three Chief Engineers (Works) as follows :—

C.E. North Iraq, primarily concerned with defences and communications.
C.E. Bases whose principal task was Port and Base development.
C.E. North Persia, primarily concerned with roads.

Phase III

Tenth Army, to fulfil its operational rôle, was relieved of Base and L. of C. commitments. These duties were taken over by the newly-formed G.H.Q., Paiforce. The M.G.R.E. Tenth Army became Engineer-in-Chief with a Brigadier R.E. for operations, and a Director of Works. An additional C.E. (Works) was appointed to South Persia relieving C.E. Bases of that portion of his task.

Phase IV

With the gradual reduction of operational commitments corresponding reductions in Engineer staffs took place. The E.-in-C. disappeared and the eventual organization became two C.E.s Works, for Persia and Iraq respectively, under a " Chief Engineer and Director of Works " at G.H.Q. The peak of Engineer activity was reached towards the end of 1942. From March, 1943, onwards reduction was steady and continuous.

Defences

Of vital interest to Britain and later to the world was the security of oil supplies from Iraq and South Persia. These provided three important targets to be defended :—

(*a*) Kirkuk Oilfields and the pipeline to Haifa.
(*b*) South Persia Oilfields.
(*c*) Abadan Island with its refinery and port.

In addition there was the Base area comprising Shaiba and the Shatt-el-Arab.

Most of Iraq and much of Persia was wide open country offering no obstacle in dry weather to mobile forces. It was therefore vital to carry out delaying actions as far north as possible. The few natural obstacles were the passes through the mountains and the larger rivers at certain seasons. An invader would, however, depend for his supplies on existing communications, i.e. railways and waterways in Iraq and roads in Persia. Therefore demolitions, even undefended, on these communications would impose delay.

Three forms of defence had to be considered—against ground attack, against air attack, and, in the last resort, a " scorched earth " policy.

Ground Defences

In 1941 and early 1942 the chief threat was invasion through Turkey. Defence lines were constructed covering Mosul and Erbil. Certain defiles of the River Tigris were prepared for demolitions and a scheme of inundation for the Habbaniya–Baghdad area was planned.

After July, 1942, came the added threat of invasion through the Caucasus. This necessitated defence lines astride certain passes in Persia and in the Rowanduz Gorge in Iraq. The principal lines in Persia were at Askaran, north of Kermanshah, Bidisurkh east of Kermanshah, Razan east of Khurramabad, and Paitak east of Khanaquin. Great attention was paid to concealment by siting rather than by camouflage, for which the characteristics of the country were well adapted.

From the operational point of view it was important for recces to be carried out and intelligence collected as far north as possible, but difficulties were encountered in attempts to pursue these activities in the Russian zone. Plans were, however, prepared for carrying out demolitions on the main natural obstacles in North Persia.

The importance of internal security was accentuated by confirmed reports that German agents with wireless sets had been dropped by parachute amongst the tribes. Guard posts were therefore built at important points on the railway. Banditry and thieving were very prevalent and static camps and all installations were heavily surrounded with barbed wire, in which was incorporated a goodly proportion of anti-personnel mines.

A large programme of improvement of strategical roads was undertaken, especially those affording lateral communications. Amongst these may be noted :—

Khanaqin–Baghdad–Haifa.
Zahidan–Kerman–Isfahan–Sultanabad.
Meshed–Teheran–Kazvin.
Andimeshk–Kut.
Mosul–Syrian frontier where it connected with the Syrian road system.

Air Defences

Most of the engineer effort was directed to the Base area and Abadan and to major oil installations. Blast walls were constructed, fire mains and reservoirs installed and a smoke screen prepared for Abadan refineries. The work was done mostly by the oil companies themselves, but R.E. certification was necessary to enable them to recover the expenditure. All had therefore to be approved by R.E. Officers. Personnel of the oil companies were trained for defence duties on the lines of the Civil Defence Organization at home.

Base installations relied for protection on dispersion, little concealment in such areas as Shaiba being possible. R.E. Bomb Disposal Sections were allotted to the Base area and Abadan. It has already been noted that the development of Umm Qasr port was a direct result of the air threat.

" *Scorched Earth.*"

A complete scheme of " oil denial " was prepared in conjunction with the oil companies. It covered demolition or immobilization of refineries, pumping stations, and storage.

Aid-to-Russia

Aid-to-Russia is worthy of special mention representing as it did a large proportion of the Paiforce effort, and, in particular, of the Engineer effort. The main routes have already been given. British (later Anglo–U.S.) responsibility ended on the line Meshed–Teheran–Kazvin–Tabriz.

Aid took three important forms—trucks, aircraft and other warlike stores.

Trucks

Trucks were shipped crated from America and were assembled at various points in Persia.

Bushire—"On the beach"—by the United Kingdom Commercial Corporation (U.K.C.C.) up to June, 1943.

Khorramshahr—truck assembly plant built by the British, operated by the American Army.

Andimeshk—Ditto.

In addition the British operated near Shaiba a plant for their own requirements. This was expanded in 1943, to replace the Bushire output for Russia, when route "B" had to be abandoned owing to tribal unrest.

The Russians took delivery of all these trucks at the assembly plants concerned and drove them in convoy to Russia using mostly Persian drivers.

As a side-line to this truck assembly the crates, known as Beta Pack, afforded a valuable timber supply which is referred to later.

Aircraft

A plant for the assembly of Douglas Aircraft shipped from America was erected by the British at Abadan in 1942 and was operated initially by American civilians, being subsequently taken over by P.G.C. The Russians took delivery of these machines at Abadan and flew them to Russia.

Warlike Stores

These included tanks, weapons of all descriptions, steel rails, jute and other materials of which Russia was in short supply. In 1944 aviation spirit manufactured at Abadan became of prime importance. This was conveyed by rail to the Caspian in rail tank cars, for which special filling arrangements were installed at Khorramshahr.

Transport of Stores

The carriage of these stores through Persia was partly by rail and partly by road. Travelling over our roads were many types of convoys as follows:—

Route "A"—U.K.C.C. with Persian drivers.

Route "B"—U.K.C.C. with Persian drivers, and Russian-controlled Persian-driven convoys.

Route "D"—American military, American-controlled Persian-driven, Russian-controlled Persian-driven and U.K.C.C.

Route "E"—British military with British and Indian drivers, and U.K.C.C.

Each type of convoy had its own characteristics and peculiarities which had to be studied by Engineers from the point of view of road safety.

The operation of British convoys necessitated the provision on route "E" of six fully hutted staging camps and three R.E.M.E. workshops—a total of 100,000 sq. ft. of hutting mostly in very isolated areas, and 30,000 sq. ft. of workshop shedding.

Ports

Considerable additions to and development of existing resources at the various ports were necessary to meet operational and Aid-to-Russia commitments.

Basra (Ma'Qil)—The main Base Port

A scheme for development of this port had already been drawn up for the Iraq Government. A firm of British contractors, Holloway Bros., had an organization available in the country. The Basra Port Directorate had a British staff and was able to undertake the design and control of all new work. The British Army's duty was chiefly to ensure the supply of the necessary stores. Three berths were reconstructed and a new one added, giving a total of nine deep-water berths. Heavy cranes were installed on special pile foundations. Lighterage facilities were greatly increased by the construction of jetties, slip-ways, and dry docks.

A subsidiary lighter basin was constructed on the east bank of the Shatt-el-Arab opposite Ma'Qil docks to enable stores arriving by sea at Ma'Qil to be put straight on to the Persian railways. Many Aid-to-Russia stores were thus transferred.

Khorramshahr—The main Aid-to-Russia Port

Six new deep-water berths were constructed under (for the most part) American supervision and were completed by June, 1943. A lighter basin was built by the British. It is of interest to note that the Persian railway did not come nearer than Ahwaz, it being the policy of the late Shah to have nothing to do with the Shatt-el-Arab in which the Basra Port Directorate controlled navigation and collected dues. Rail and road connexions to Ahwaz were therefore an integral part of the development of this port. All these facilities were completed early in 1943. This port from the outset was operated by the American Army.

Bandar Shahpur (Bandar Gulf)

This was the terminal port of the Trans-Persian railway and had a wooden jetty sufficient for two vessels. In 1942 a contract was placed through the Indian Government for a steel screw pile jetty, to be built by Burn, Braithwaite and Jessop giving a further three berths. After many delays due to the difficulties in obtaining materials and skilled artisans from India the work was completed in October, 1943. This port was operated by the Americans from December, 1942, onwards.

Umm Qasr

It was desired to have a port clear of the Shatt-el-Arab as explained earlier. It was therefore decided in 1942 to construct three piled deep-water berths at Umm Qasr. By April, 1943, when the change of operational situation led to its abandonment one berth had been completed and was in use. The development of this port included the usual port facilities and rail and road connexions to Shaiba.

Kut—Riverhead Port

As part of the Aid-to-Russia programme a Riverhead Port was established at Kut. Dockyards for the I.W.T. and lighter berths were constructed on the east bank of the Tigris. Road and rail connexions with Baquba were provided and a lateral road was planned and partially constructed to connect Kut to the Persian L. of C. Engineer work at Kut included the provision of accommodation, power station and considerable workshops and stores shedding.

Abadan

This port, owned and operated by the Anglo-Iranian Oil Company (A.I.O.C.), was fully employed for their own purposes. An additional lighter basin, known as Army Creek, was constructed by the W.D. as part of the drum plant project mentioned later.

Ahwaz—Riverhead Port.

At Ahwaz, the limit of navigation on the Karun river, lighter wharves were reconstructed for I.W.T. use. Considerable quantities of supplies, in particular, were moved by river to the Ahwaz Base.

BASES

Shaiba—The Main Base

This base was started immediately after the arrival of the first troops in 1941, on the site of our former base in the 1914–1918 war. Its desert location made concealment of the vast installations involved quite impossible and reliance was therefore placed on dispersion as a measure of protection against air attack. As might be expected this dispersion considerably increased the Engineer effort required for the construction of roads and earthworks for Transportation. Some of the early accommodation provided, for offices and hospital wards in particular, was built below ground as a hot weather measure. The effect was very satisfactory but trouble arose during the winter when the water table rises considerably. Serious damage was further caused to these underground quarters by floods in 1943. Much of this might have been avoided by more attention to drainage. The unfortunate result was that a ban was placed on the provision of further underground accommodation.

Andimeshk/Ahwaz—Base for Persian L. of C

Suitable ground to which rail and road access could be given was insufficient at either of these places for the complete base. It was therefore decided to split the base putting some installations at each. Here, as in Shaiba, wide dispersion was the rule. By February, 1943, when only partially constructed, the change in the operational situation led to work being suspended.

Musaiyib—Base for Iraq L. of C

This was a well-planned base served by two separate railway systems, the metre gauge (Basra–Baghdad) and the standard gauge (Baghdad–Mosul), a special link with the latter being laid from Baghdad forty miles away. This system would have enabled the base to feed operations on the Turkish frontier without trans-shipment. A separate trans-shipment yard was also provided for the handling of stores to be passed through direct from Shaiba. Work on this base was practically completed when suspension was ordered early in 1943.

Advanced Bases

Projects were in hand and some earthwork had started on four advanced bases—two on each L. of C.—when the operational necessity ceased. Khanaqin development continued however, for its use as the railhead for Aid-to-Russia Route "E." It was also the military railhead for the subsidiary Persian L. of C. via Kermanshah.

Summary.

The Engineer effort on these bases included some 4,000,000 sq. ft. of workshops and stores shedding, many miles of roads and earthwork for railways and large areas of covered and open hardstandings. Nearly 2,500 tons of cold storage were built, 4,000,000 gals. of filtered water supplied daily, and electrical installations of over 5,000 KW. provided.

Roads

At its peak the road programme involved some 7,000 miles, of which over 6,000 represented main roads, either Aid-to-Russia or strategical. Over 1,500 miles were fully bituminized and 5,000 were given an all-weather gravel surface.

It may be noted that very little mechanical equipment was available for main roads. At its peak, in the autumn of 1942, the maximum assistance was represented by five operating platoons.

Iraq

In Iraq the P.W.D. already maintained many hundreds of miles but the majority of this length was fit for dry weather use only and not built for continuous heavy traffic. To achieve a higher standard a grant-in-aid was made to the Iraq Government. Bitumen was supplied free where needed and some plant was provided on loan. This grant-in-aid reached a maximum of £14,000 monthly at the end of 1942. Certain roads were constructed or improved entirely at British expense and largely by military labour. The most important of these were :—

Basra–Shaiba high level.
Baghdad–Haifa, via Habbaniya by-pass (under C.E. Palestine until August, 1943).
Baquba–Kut.
Kut–Andimeshk.
Mosul–Tel Kotchek.

These roads were built to an all-weather specification and were two-way roads (20 ft.) with a gravel or bitumen surface. Bridges and culverts were built for Class 40 loads. In the Kirkuk area the oil company had a specification for an oiled road which was adopted in many cases in North Iraq. For most bitumen roads A.I.O.C. products were used. These will be described later. On the Baghdad–Haifa road, a natural bitumen obtained from an asphalt lake at Abu Jir, 120 miles west of Baghdad, was also used. This bitumen required fifteen per cent of fluxing oil.

During 1943 a by-pass road was constructed to the south of Baghdad crossing the Tigris by a boat bridge at Karradah. This by-pass relieved the tremendous congestion in the streets of Baghdad.

The total expenditure on roads in Iraq, including the grants to the P.W.D, in four years was approximately £4,000,000.

Persia

In Persia the Roads Department of the Ministry of Ways and Communications had an elementary organization only, was corrupt and inefficient and in 1941 not very co-operative. It was therefore necessary to establish a British organization for the Aid-to-Russia road programme, of 3,000 miles initially, to which was soon added over 1,000 miles of lateral roads. The Engineer organization available in October, 1941, was represented by one C.R.E. with a staff of three R.E. officers, and a handful of B.O.R.s. On the advice of the British Minister in Teheran it was decided to call in the firm of Kampsax, a Free Danish firm of engineers previously employed on the construction of the Trans-Persian railway. They had a knowledge of the country and conditions, contractors and resources, and employed many Persian-speaking Europeans. They entered into a contract with the W.D. as consultants and agents.

The general standard of main roads was fair. They consisted of a 16-ft. loose metal surface, mostly bridged, but only carrying light traffic. Aid-to-

Russia envisaged 1,000 tons daily as the eventual target on most routes. The country was mountainous with many difficult passes, the climate ran to extremes of heat and cold and long stretches of road passed through arid desert, dusty and waterless. The watered, and therefore fertile, stretches were generally malarious.

Initial Programme

The Initial Programme consisted of :—

(*a*) Widening to 20 ft.—in some cases 23 ft.
(*b*) Strengthening of the base where necessary—usually by heavy metalling as soling was rarely available.
(*c*) Strengthening of, replacement of, or diversions to, bridges where necessary.
(*d*) Drainage and culverting, especially in the mountain sections.
(*e*) Provision of large stocks of metal for maintenance, which consisted of removing corrugations by hand and regular additions of loose metal.
(*f*) A two-year programme for bitumen surfacing on Routes " D " and " E," using a 1 in. sand carpet. (Topeka).

All new construction was arranged so as to cause no obstruction to through traffic. No mechanical equipment, except a few rollers, was available from military sources. A few contractors possessed one or two pieces of road plant but otherwise all work was carried out by hand.

By June, 1942, Routes " A " and " B " were in full operation for Aid-to-Russia and Routes " D " and " E " in extensive use by military traffic.

A route of special interest was the great strategical artery linking India to West Persia. The Indian section from Quetta to Zahidan has been described in *The R.E. Journal.* From Zahidan to Isfahan the road runs for the most part through forbidding desert country in which the towns of Bam, Kerman, Yezd, and the few villages are veritable oases. East of Bam is the famous Lut Desert of ever shifting dunes, 60 miles wide, liable to fierce sand storms and scorchingly hot in the summer. A tower 40 ft. high was built in the middle as a landmark in olden days. The road is now well-marked with a good gravel surface, started by C.E. Persia and completed under Indian control. Reinforcements for the Tenth Army from India were intended to use this route in 1942. Camping sites and water supplies had been prepared, but this intention was defeated by the River Indus, which rose in flood, destroyed its road and railway bridges, and thus barred the exits from India.

Organization

By March, 1942, more military staff was available, a C.E. North Persia was appointed and gradually a duplicate organization was set up—R.E. staffs responsible for policy, general direction and the supply of stores; Kampsax for construction and all payments. R.E. staffs were still woefully short of either Officers or N.C.O.s with previous experience of road construction. Even by August, 1943, when the contract terminated and roads in our care had dwindled to 1,500 miles, the R.E. staff available was still barely sufficient for the job. There is no question that without Kampsax assistance the start of Aid-to-Russia, so far as road traffic is concerned, must have been seriously delayed.

American Assistance

American Engineers meanwhile were constructing a new road across virgin desert from Khorramshahr to Andimeshk following roughly the line of the railway. As most of this 180 mile stretch is liable to floods the road was generally carried on an embankment 2 ft.–2 ft. 6 in. high. The earthwork

was tremendous but the American Engineers were well equipped with road plant and the road was completed in about ten months to a 26 ft. first-class bituminized highway and opened to regular traffic in April, 1943.

By June, 1943, American assistance became available on the remainder of route " D," Andimeshk to Kazvin, though general responsibility remained that of the British C.E. By this time Route " D " was completely two-way and about fifty per cent bituminized. Officially American assistance was rigidly defined—in practice co-operation was whole-hearted and few requests met with even hesitation. The division of work was that the Americans, with the resources of plant, undertook all reconstruction and realignments and maintenance of approximately fifty per cent of the total length, while the British, with the greater experience of contractors and civil labour, undertook carpeting, drainage, and the maintenance of bridges and retaining walls. It is a tribute to the elasticity of both Engineer organizations that much overlapping of boundaries and many local rearrangements were achieved without friction.

Road Safety

With the ever increasing Aid-to-Russia, traffic congestion was becoming noticeable at many points. Traffic control over these long distances was difficult and accidents were increasing rapidly At the instance of the Americans, a Highway Traffic Committee was formed in August, 1943 and held monthly meetings It was presided over by a Senior American Staff Officer and was attended by representatives of British and American Engineers and Provost and major road users, including the Russians, U.K.C.C. and A.I.O.C. Traffic regulations (based largely on British Convoy rules) were drawn up, time schedules issued for convoys, and safety measures introduced. Both Americans and Russians instituted courses of training for their Persian drivers. The Engineers made special efforts to improve dangerous corners and erected numerous traffic signs, adopting the Russian colour-scheme of blue on white. Apart from the possible political implications of red, it was found that these colours were in fact the most suitable against the Persian landscape. A further step, to relieve congestion at Hamadan where routes " D " and " E " converged, was to route Russian convoys from Malayer on Route " D " via Qum and Teheran. This had disadvantages from the British point of view, but was accepted in the general interest.

Methods of Construction

The British used hand methods for the most part and work on gravel roads calls for no particular comment. The loose metal surface was retained, any form of water-bound surface being ruled out by the impossibility of obtaining sufficient water. In the early stages the 1 in. sand carpet was the normal form of bitumen surface though in the passes, especially on hair-pin bends, bitumen macadam was occasionally used.

The Americans had many road Engineers, both officers and other ranks, with experience of road construction in conditions almost identical with those in Persia. Training in soil physics and chemistry enabled them, with field laboratory equipment, to determine rapidly any treatment required by the existing base and the type of fill to be used. Base stabilization and consolidation were considered of first importance and much effort was concentrated on these. The result was that a light specification could be adopted for the protective and wearing surfaces. To assist in consolidation and compaction of the existing soil, traffic was frequently run over a newly consolidated base for many days, or even weeks, before surfacing was commenced. The principal form of surfacing used was " Inverted penetration " which, as its name

indicates, consisted in spraying bitumen to the required thickness and covering with a carefully graded gravel. The methods employed are fully described in a manual entitled *Military Roads in Forward Areas*—No. 23, in a series of Manuals of Engineering Practice, published by the American Society of Civil Engineers.

R.E. Officers soon appreciated the advantages of these American methods and during 1944 we adopted them, when circumstances permitted, on other routes. An improvement on the American surface was found to be the use of a coarser gravel, especially on hill sections.

Materials

Road metal was obtained largely on site, by digging and screening the many deposits of broken and weathered limestone. Sand, generally from river beds, had often to be transported many miles, making sand carpets an expensive treatment.

Three kinds of bitumen were used:—

MC2—a 50 per cent bitumen cutback, 120 Penetration, used for priming coats, road-mix, and occasionally for sealing in cold weather.

S125—A "straight" product, 60–70 Penetration, equivalent to a 70–75 per cent bitumen cutback, used for wearing surfaces and seal-coating.

Both the above are A.I.O.C. products from the Abadan refineries.

Russian Mk. V.—a solid bitumen, 40 Penetration, from the Caucasus requiring 30 per cent fluxing at a high temperature and rather difficult to use.

Attempts were made to get Russian Mk. III which is similar to S125 but protracted Diplomatic negotiations and transport difficulties were the cause of failure to obtain any.

Snow Clearance

No less than five major passes on Routes "D" and "E" were above 7,000 ft. and blocked by snow for three months annually. Other exposed sections of lesser altitude were also liable to be blocked for periods of several days at a time. Snow ploughs—mostly lorries adapted for the purpose—were supplied during 1942 and three British Mechanical Equipment Operating Platoons were allotted for snow clearance during the winter 1942–1943. In 1943–1944 the Americans looked after Route "D" and an Indian Mechanical Equipment Operating Platoon was used on Route "E" and elsewhere. In 1944–1945 the one Indian Platoon undertook all snow clearance, using much of the American equipment lent for the purpose. Much hand labour had to be employed in addition both on the passes and elsewhere. They were provided with special hardwood shovels made in one piece. The ordinary steel shovel was found to be quite unsuitable as the snow freezes to it.

Summary

This was one of the larger programmes of road construction and maintenance undertaken during the war and the maximum R.E. supervisory staff ever available was three C.sR.E. and eight Works Sections who had many other duties in addition. Practically all new construction and bitumen work was carried out by contract but the majority of maintenance was normally by direct labour.

British expenditure on the roads in Persia during four years was nearly £13,000,000.

Bridges

In the course of the extensive road programme described above many new bridges and many hundreds of culverts were constructed. The majority of bridges were single span, masonry arches or reinforced concrete slab roadways on steel bearers, but a few were of more ambitious design. In addition, many bridges were strengthened or widened to take heavy military traffic, and a large number of causeway diversions were constructed where existing bridges could not be strengthened or replacement was uneconomical.

Many of these bridges afforded interesting problems both of design and construction, and in Persia scope for much allied co-operation. Worthy of special mention is Hull bridge, which was built across the Shatt-el-Arab about half a mile above Ma'Qil docks, where the river is divided into two branches by Coal Island. The western branch is fully piled but the eastern branch is unique in having a central sinking span of 70 ft. to allow river traffic to pass. The bridge, named after the Chief Engineer responsible for its design and construction, Brigadier G. B. Gifford Hull, afforded the only direct rail and road communication between Iraq and South Persia. It was thus a valuable link in our lateral communications. The bridge was cut for river traffic for six hours daily.

A full description of the bridge and its construction appeared in *The R.E. Journal* of June, 1944.

E. & M. Services

Water Supplies

At various points in the Command we supplied daily some 5,000,000 gals. of filtered water and a further 1,500,000 gals. of settled and treated water. 450 pumping sets were in daily operation and well over 1,000 miles of piping ranging from ½ in. to 8 in. were laid. At Shaiba alone 1,800,000 gals. of water were delivered daily from the Shatt-el-Arab twenty miles away.

In these countries established communications usually follow rivers and it was generally possible to take military supplies of water from natural surface sources or their off-shoots—irrigation channels or *qanats*. Some areas of both Iraq and Persia are impregnated with salts making surface water supplies, though health-giving, unpleasant to the taste and unsuitable for boilers and railway engines. In such areas bore-hole supplies were put into use. Some of these bore-holes were 250 ft. deep though supply was usually semi-artesian and, when tapped, water rose to within 100 ft. of the surface. Two bore-hole supplies worth recording were those at Hasratabad, half way across the desert stretch between Bam and Zahidan, and at Wadi Mahomedi over 120 miles west of Baghdad on the Haifa road.

To keep civilian labour, and especially road labour, at work during the the heat of summer involved considerable water distribution and the shortage of tankers in the early days necessitated the improvisation of water-carrying vehicles.

The normal G.1098 water supply equipment carried by Divisional R.E. on home W.E.s was inadequate for countries like Persia and Iraq, and all R.E. Field Units were raised to the Indian Divisional scale in 1942.

Electrical Supplies

A total installed supply of over 10,000 KW. was provided, including 3,000 KW. in the Shaiba Base area operating on a grid system. Large W.D. installations also existed at various times at Khanaqin, Kermanshah, Baghdad, Kut, Mosul, Musaiyib, and Andimeshk. In addition many small independent generating sets were supplied for hospital needs, pumps, and to meet Signals' requirements.

In Persia both water and electrical supplies were frequently joint British and American installations.

Air Conditioning and Refrigeration

A considerable number of air-conditioning sets were installed for operating theatres, hospital wards, heat stroke treatment centres, signal exchanges and certain amenity and welfare buildings.

A 2,000 ton cold store was erected at Basra (Ma' Qil docks) in 1943, with 200 ton stores at Baghdad and Ahwaz and four 70 ton refrigerator barges for transport.

Ice plants at various stations produced 75 tons of ice daily and some 280 domestic refrigerators were provided for hospitals, messes, and institutes.

The maintenance of all this special hot weather plant was a big factor. Experience showed that there was ample justification for the formation of special sections of E. & M. Companies for this purpose. The sections, designated "Polar Units", consisted each of one officer, one supervisor (senior N.C.O.), four electricians, two fitters, two carpenters and one tinsmith, with their own transport, not less than a jeep and two 15 cwt. trucks. The sections were used in advisory and supervisory capacities, and for urgent maintenance calls on plant installed in operating theatres, X-ray and heat-stroke centres. Three such sections were required working respectively in North Iraq, South Iraq and South Persia. Lack of sufficiently skilled personnel for this class of work was very marked,especially in I.E. units, on which Paiforce was chiefly dependent.

Accommodation

During the four years of occupation of Iraq and Persia 2,000,000 sq. ft. of hutting for living and dining accommodation, hutted hospital wards for 11,000 patients and many amenity and welfare buildings were provided.

The varieties of conditions in different parts of the Command, varying availabilities of indigenous materials, and the necessity to relate construction to the type of labour available, prevented the rigid adoption of a standard hut. Initially many Middle East standard designs were adopted, but climatic conditions in Paiforce necessitated many modifications. Similar remarks applied to the construction of hospital wards.

Both time and money might have been saved in the early stages if more information had been available on the subject of local materials and methods of construction. This side of Engineer Intelligence is apt to be overlooked. Mention may be made of the local gypsum—called "juss" in Iraq and "gatch" in Persia—and the several types of products suitable for partitions, ceilings, and heat insulation manufactured from such materials as reeds. The ideal local form of construction to meet hot weather requirements as well as cold—mud or mud brick walls up to 2 ft. in thickness—was of course generally ruled out by the time and transport factors, but was often made the basis of individual or unit effort. Persian bricklayers are adept at domed and arched roofs built without formwork, useful for small buildings such as messes, and cookhouses.

A very successful cooling device was the "Khas-Khas Tatti", known in India, camel-thorn being usually the medium through which the water dripped.

Oil

As stated earlier security of oil supplies was vital to the Allied cause and was the primary object of Paiforce. As the war went on the development of these supplies became more and more a military object and by 1944 had grown to one of the main Engineer efforts in the Command.

In 1941 and 1942 with the threat of invasion and defence uppermost our chief concern was with security measures, including arrangements for immobilization. For operational needs and for Aid-to-Russia convoys the augmenting of local supplies had to be undertaken. Towards the end of 1943 the expansion of A.I.O.C. resources began to need military assistance apart from the supply of stores. An Engineer Assistance Group consisting of one Engineer Battalion, one Army Troops Company, one Artisan Works Company and several Pioneer Companies, was employed on the Refinery Expansion Scheme at Abadan. These units worked under their own officers who acted as assistants to the A.I.O.C. experts. An article on the work of this group was published in *The R.E. Journal* for June, 1947. In 1944 it became necessary for the Army not only to assist the A.I.O.C. but to take on important projects, chiefly connected with the increasing demand for aviation spirit.

Stores, Workshops and Factories

By the end of 1942, the E.S.B.D. at Shaiba held about 130,000 tons of Engineer Stores, and stocks never fell below this figure. Including Andimeshk, Musaiyib and advance depots, the total holdings reached 180,000 tons. At the peak 100,000 tons monthly were handled of which 70,000 tons were obtained by local purchase. During the whole period approximately two-thirds of the materials used were of local origin.

The Andimeshk depot was used for a time as a transit depot but at the end of 1943 it was decided to close down both Andimeshk and Musaiyib and all stores were back-loaded to Shaiba bringing the total holding there to 180,000 tons, which figure remained more or less constant, in spite of efforts at disposal.

Local Purchase

The commonest items obtained locally were bricks, lime, gravel, juss (gatch) and ballies (poplar poles). Cement was imported from Syria by road, but up to 1943 a considerable quantity was also obtained from the Persian Government factory in Teheran. This supply had to be abandoned owing to deterioration in quality of the cement. Copper was obtainable in Persia and 360 tons were in all purchased to meet electrical, Signals, and R.E.M.E. requirements. Some hurried purchases of steel were necessary in 1942 to meet defence needs. It is of interest to note that the steel was disposed of at a profit three years later. In 1942 also a contract for the manufacture of camouflage materials was entered into in Persia. A large quantity was supplied but the contract broke down owing to corruption on a vast scale. The highest monthly value of Local Purchases over a period of four years was £150,000 in Iraq and £100,000 in Persia.

Timber

In the early stages, timber was imported from India and East Africa, but apart from ballies little was available locally. An endeavour was therefore made to obtain timber from the Caspian seaboard which was, of course, in the Russian zone. The timber available was all hardwood consisting of local varieties of beech, alder, maple, oak, and walnut. It was felled and roughly squared in the forests and dragged to the roadside, where it was collected by lorry and removed to the saw mill.

Our first contract was placed with the U.K.C.C., but although completion of delivery was promised in six months, deliveries actually took two years. There were many difficulties to be overcome. Permits had to be obtained from the Persian Government to cut the timber. Negotiations had to be entered into to obtain exemption from a new timber tax imposed by the Persian Govern-

ment. The rigid control by the Russians of the Caspian zone prevented the entry of British Officers to organize removal until passes were obtained. Passes were granted grudgingly and for such short periods that they were of little use for visiting the forests. Obstruction occurred in many forms, chiefly in the hope of graft—railway wagons would be "missing" and road transport engaged would be commandeered by Local Government officials.

This contract was finally terminated in June, 1944, and Direct Contracts were placed with the timber owners for further supplies. By this time world shortages had resulted in all imported supplies ceasing and also in demands on Paiforce from Middle East. The Russians by now were more co-operative and the new contracts progressed far more smoothly.

Up to the time these contracts terminated in October, 1945 a total of 44,500 cu. metres had been obtained from the Caspian giving a total of 27,000 tons of sawn timber produced by the Teheran saw mill.

Great use was made of the Beta Pack timber obtained from the crates in which the American trucks reached this country. The crates were dismantled and provided a large quantity of deal scantlings and boards. We obtained one hundred per cent of the output from Shaiba and twenty-five per cent of that from Khorramshahr and Andimeshk. This timber was used not only for the crating of machines, etc., being transferred to other theatres, but was also used extensively in constructional work, Trusses of the Warren girder and other types used in shed construction were manufactured at the Base, also doors, windows, and many articles of furniture. In the course of dismantling the crates over 100 tons of nails were salved, straightened, and used again. These nails were of great assistance in 1944 when imports were extremely short.

Bitumen

The great majority of the bitumen used was obtained from the A.I.O.C. at Abadan either in bulk or in barrels. During the four years we used 67,000 tons on roads and airfields, and 80,000 tons were supplied to the Americans for road work executed by them.

Some 3,000 tons of Russian Mk. V bitumen was obtained for use on the roads in North Persia. The only other supply of which any considerable use was made was a natural asphalt lake at Abu Jir 120 miles west of Baghdad. This was used on the Baghdad–Haifa road.

Workshops

Workshops, manned largely by civilian labour, were set up at Basra, Baghdad and Ahwaz. These manufactured joinery, ironmongery, metal work of all descriptions, and castings. The number of civilians employed reached at one time a total of 2,500.

Factories

Many factories were set up during the four years of occupation. A description of some of the more important will be of interest.

Drum Plant

This plant was constructed at Abadan during 1943 and put into operation by the Drum Container Production Unit in January, 1944. Of American design, the plant consisted of:—

One jerrican line.
One double and one single 5-gal. drum line.
One 36-gal. drum line.

The plant was operated by a staff of 8 Officers and 308 B.O.R.s, including a R.E.M.E. detachment for the tool room. The labour consisted of an average of 600 Indians from Pioneer Companies, operating in two shifts.

These men were mostly unskilled, but were taught various trades and how to operate the machines. Their progress amounted to a considerable achievement.

Many factors conspired to prevent the smooth working of the plant, but the total output during its eighteen months of operation was 36 gal.—735,000 ; 5 gal.—1,462,000 ; Jerrican—65,000.

Oxy-acetylene Generating Plant

During 1943 we installed at Basra an oxygen plant with a nominal capacity of 500,000 to 600,000 cu. ft. monthly. The plant was a mixed one supplied from India, some of the machines new, others so old that considerable overhaul and repairs were necessary before they could be put into operation. Many items of accessory equipment had also to be manufactured. The issues rose to about 100,000 cu. ft. per month.

The acetylene plant was also installed in 1943. It was new and generally very satisfactory, but extra refrigerating plant was required during the hot weather. The capacity of the plant was 120,000 cu. ft. monthly, and it worked in full production. Issues were made to the American Army and to meet important civilian needs.

Juss Factory

Juss is the local name in Iraq for gypsum which occurs on the higher ground around the shores at the head of the Persian Gulf. It is calcined locally in various crude ways to give a " plaster of Paris " (usually heavily diluted with inert matter) which is used extensively both as a mortar for brickwork, and as an internal wall plaster. Owing to the impossibility of obtaining from contractors material to any reasonable specification, attempts were made to install a plant for crushing and screening the raw material and then calcining it in oil-fired rotary kilns. After considerable experimental work success was achieved and an output of 90 tons per shift was obtained. Italian prisoners of war were used for all work except maintenance of machinery. The material was used not only as mortar and plaster, but also for pre-cast blocks. These have a high insulating value for walls but must be protected as far as possible from damp.

Thatchboard Factory

Thatchboard is a local product manufactured at Basra from reeds that grow in the marshes of the Hamar lake. The reeds, cut while still tender, are compressed in a vertical press. In this condition they are bound by vertical wires of 14 gauge at regular intervals on both sides of the board, and a machine forces wire crotchets through the reeds to hold the wires together. Boards are made in one width (5 ft. 3 in.) and usually are in 8 ft. lengths giving an area of 42 sq. ft. There are two thicknesses, 1¼ in. and 2 in. The board is often used itself as a hut wall or even roof, in which case it is generally painted with bitumen and then plastered with mud. It is also used for ceilings, partitions, and linings. Its insulating qualities are excellent, and it does not appear to harbour vermin. It is understood that, should vermin be found, spraying with alum solution is an efficient antidote. Thatchboard gives off a slight pleasing aromatic odour.

Teheran saw mill

This saw mill was put into operation in the summer of 1942. It had two large log frame saws as well as several circular and band saws. Some fifty civilians and six B.O.R.s were employed on sawing up the timber (hardwood) obtained from the Caspian seaboard. The output rose to 2,000 tons of sawn timber monthly.

Transport and Labour

Transport for Works

Civilian transport in both Iraq and Persia was limited in quantity and what existed was hampered by lack of spares and tyres. The latter was overcome by the issuing of W.D. tyres on hire agreements, to both Works and transport contractors. By this means a number of civilian vehicles were from time to time employed to supplement W.D. transport. In Iraq, a ceiling for such employment was fixed in order to leave enough transport for civilian use.

In 1942, the R.E. obtained a number of vehicles—part W.D. supply, part civilian types (purchased or hired)—and operated them as a R.E. Pool. Civilian drivers were trained, notably at Baghdad and Andimeshk, by the Mechanical Equipment Operating Companies. These vehicles were somehow kept on the road despite many difficulties, the chief of which was the lack of any proper maintenance organization. In September, 1943, what remained of these vehicles, and their drivers, were taken over by S.T., and formed into three Works Service Companies of four platoons each, staffed by the R.A.S.C. and operating under the control of C.E.s.

Transport for Personnel

The normal W.E. transport of C.R.E.s (Works) and Works Sections is quite inadequate for countries the size of Iraq and Persia, where units were spread over long distances with several detachments. As a further complication most of the Works Sections were formed in the Command from resources available, and these unfortunately included little transport. In 1942 a number of cars were obtained by local purchase. These cars covered vast mileages, and troubles arose through lack of spares and old age. It was a distinct achievement on the part of many R.E. Units to have kept their transport on the road at all. Towards the end of 1943, transport was put on a better basis by the formation of a pool of Personnel Transport, controlled by C.E. Paiforce. This pool had a fixed War Establishment and consisted partly of W.D. vehicles and partly of the old cars which were still road-worthy. Vehicles from this pool were allotted as required to supplement the W.E. transport of units according to their commitments. This problem is likely to arise in any eastern country where R.E. activity is wide-spread.

Military Labour

A number of Engineer Units, mostly I.E., were employed in the Base and on the L. of C. and several companies of Indian Pioneers were available at various times.

Civilian Labour

Local civilian labour resources were fully exploited though skilled artisans were rare. Conditions of employment and rates of pay were controlled by a Joint Labour Committee on which all major employers, both military and civilian, were represented. Local sub-committees operated in all the important stations, the American Army being represented on the Persian sub-committees. These committees worked under the general direction of the D.P.L. at G.H.Q.

All labour in Persia, and to a limited extent in Iraq, was issued with rations free of payment, these issues being taken into account in fixing their rates of pay. Contractors' labour was included in this scheme, rations being issued in bulk to contractors, with numerous safeguards to ensure that they actually reached the labour. The administration of this rationing scheme for labour employed on works devolved upon the staffs of C.E.s and C.R.E.s and represented considerable additional work. The results of labour receiving

regular food in this manner were reflected in the improved quantity and quality of output.

The maximum number of civilians employed at any one time was 130,000 towards the end of 1942.

Contracts and Finance

Kampsax

The unusual type of contract entered into with Kampsax has already been mentioned. Originally for the road programme, it was extended to include all types of work—camp services, installations, and hutting—with which the wide-spread Kampsax Organization was best able to cope. In two years' operation Kampsax handled work to the value of £10,000,000.

Construction Contracts

In Iraq capable Engineering contractors were few, and were chiefly represented by British firms such as Holloway Bros., and Balfour Beattie & Co., who were already operating in the country for the P.W.D., Basra Port Directorate, and the R.A.F. There were a few Iraqi firms in Baghdad and Basra.

In Persia there were several Scandinavian and other firms under European management. These were generally reliable but, paying as they did salaries to Europeans commensurate with the cost of living in Persia, their prices were high, and for ordinary hutting or road work they could not compete with local contractors. On the other hand for certain types of work where reliability and a high standard of execution was essential—e.g. bridge construction—it was an economy to employ such firms. Local contractors, the majority of whom were Armenian, were usually speculative financiers, with no engineering knowledge at all, but employing an engineer or two, very often "displaced" Europeans, refugees from their own countries. The standards of honesty and commercial probity were low, but, thanks to Kampsax experience and ours gained with them, it was possible by 1943 to sort these out and select the more desirable ones. All were eager to undertake any work but discrimination had to be used in inviting them to tender, depending upon the area of operation, their resources, and the type of work under consideration. There was a general inability to understand specifications and tendered prices were not always a reliable guide. Quotations were often obviously too low and it was extremely rare for contracts to be accepted at the original tendered price. The principle of negotiation was adopted, based on our knowledge of current prices, and contractors were "persuaded" to amend their prices accordingly. If negotiations with the original lowest tenderer were unsuccessful, the next lowest would be approached and so on. The approval of the Financial Advisor was sought and obtained to this somewhat unusual method of procedure. Certainly in the last two years better work at better prices was obtained by these methods. Account had to be taken of the great variation in conditions in different parts of the country. Shortage of skilled labour or of materials, the long hauls occasionally required for such materials as sand and gravel, and other factors all made comparison between different areas impossible. Much discretion was thus permitted to the C.E. and his C.R.E.s.

In both countries in the early days, we were greatly handicapped by the shortage of qualified Surveyors of Works.

Stores Contracts

Shortage of materials in constant demand, and in some cases deliberate hoarding by suppliers, made the central control of the purchase of stores most

necessary. It was therefore the custom to enter into stores supply contracts for the supply of such materials as bricks, ballies, lime, and gatch and to supply these free to construction contractors, thereby avoiding their competition in the local markets. In Persia, in 1943, a Joint Engineer Conference, of which C.E. Persia was President, was held monthly with the American Engineers. The chief object of these meetings was to pool information on local resources and requirements and avoid competitive buying.

Contracts entered into for the supply of Caspian timber have already been discussed.

Contracts of special interest were those for the supply of road metal on gravel roads in Persia. In the early stages we employed large main contractors and prices were too high. At the end of 1943 a new method was tried, with prior G.H.Q. approval, of placing contracts with the headmen of villages along the road. These were of necessity single tender contracts, but by negotiation lower prices were obtained and supplies became more regular. Another advantage of this system was that all the money went straight into the pockets of the local villagers, instead of largely into those of some wealthy financier in Teheran.

Some figures of expenditure will be of interest. At the end of 1942 the average monthly expenditure on Works and the local purchase of stores exceeded £1,000,000. By the end of 1943 this had fallen to £500,000 and by June, 1945 the average monthly expenditure was £240,000 only. The total Allied Expenditure on roads in Persia, the largest single item, was nearly £24,000,000 in the course of four years, the British share of this being approximately £13,000,000.

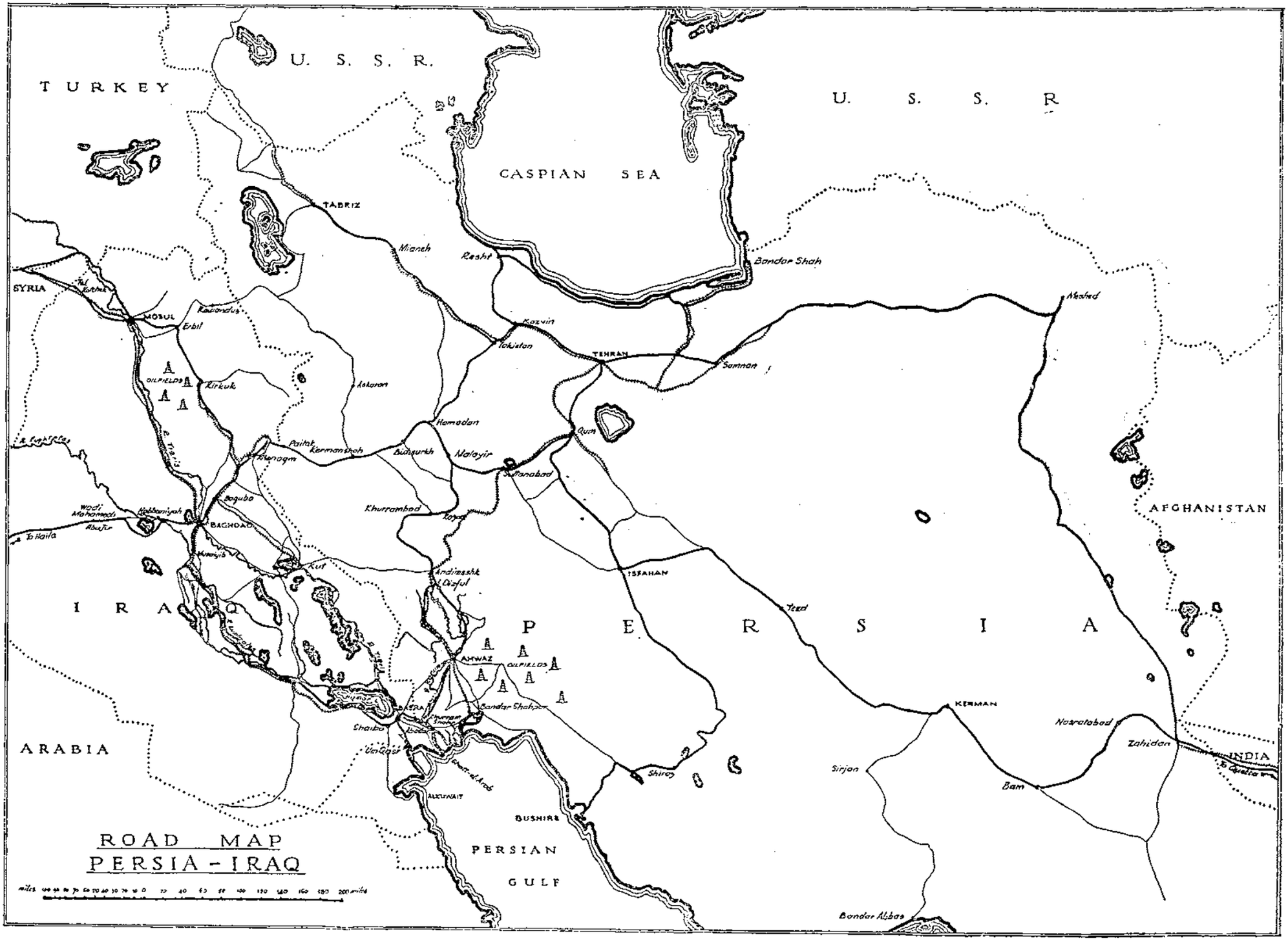
Epilogue

So ends the story. Little glamour accrued to Tenth Army and Paiforce and many members often felt they were as forgotten as the Fourteenth Army.

The engineers fought their battles with the climate, the aggravating dilatoriness of the East, the lack of so many things that mattered and the feeling that few, beyond their own superiors, knew what they had achieved. The total aid carried by road to Russia over three years is but one illustration of this achievement.

In the larger stations the engineers shared, and struggled to improve, the lot of everyone else, but this was only part of their existence. It was life in the outposts which will be recalled by many—that village 400 miles from the nearest Army Post Office and N.A.A.F.I., those black tents in the scorching desert with the two small white ones beside them, that hut on the top of the pass in a blinding blizzard—with the chief topics of conversation the date of the next mail, tomorrow's temperature, or the number of feet of snow at Windy Corner in the morning. One Royal Engineer will tell his grandchildren of a full hour's entertainment given to an audience of four by Joyce Grenfell.

Royal Engineers and Indian Engineers were alike cheerful and efficient and when in years to come they gaze on their "Pink Elephant" (the Paiforce sign) and Defence Medal they can truthfully say, "Much was achieved by few with little."


U. S. S. R.
TURKEY
U. S. S. R
CASPIAN SEA
TABRIZ
Mianeh
Resht
Bandar Shah
SYRIA
Tel Kotchek
MOSUL
Rowanduz
Erbil
Kazvin
Tekistan
TEHRAN
Semnan
Meshed
OILFIELDS
Kirkuk
Askaran
Hamadan
Qum
Paitak
Kermanshah
Bidgurkh
Malayir
Sultanabad
Khanaqin
Baquba
Khurrambad
Wadi Mohammedi
Habbaniyah
Abu Jir
BAGHDAD
To Haifa
Kut
Andimeshk
Dizful
ISFAHAN
Yezd
AFGHANISTAN
I R A Q
P E R S I A
AHWAZ
OILFIELDS
Bandar Shahpur
KERMAN
Nasratabad
Zahidan
INDIA
To Quetta
Shaiba
Umm Qasr
Sirjan
Shiraz
Bam
ARABIA
KUWAIT
BUSHIRE
PERSIAN
GULF
Bandar Abbas
ROAD MAP
PERSIA - IRAQ
miles

MORE ABOUT COMMUNICATIONS WITHIN THE DIVISIONAL ENGINEERS

By Lieut.-Col. G. F. Hutchinson, D.S.O., R.E.

Introduction

Lieut.-Col. Henniker's article in the March *Journal* is an interesting one, but not necessarily one with which everyone will agree. I cannot agree myself, for instance, that the R.E. communications within a division were a failure in the last war, which seems to be the assumption in his paper. Nor do I feel from my own experience that the regimental net would necessarily be an improvement. However, if there is one thing that is true about war, it is that the experiences of one officer or formation may be quite different from those of another. Let us therefore examine his conclusions in more detail.

The Regimental Net

The regimental R/T net was developed by the R.A.C. to facilitate control of their tanks in battle, when co-ordination of the whole regiment was necessary. It was not invariably employed. If, for instance, squadrons were being fought in individual rôles, then squadron nets were used. Nor would it even be true to say that the regimental net was always used when all squadrons were under regimental command. It came down to a question of the task and the ground. If either demanded it, then the regimental net would be employed, but not otherwise.

In the case of the Divisional R.E., it was normal for all companies to be under the C.R.E.'s command, but they were usually being employed on quite different tasks, or on similar tasks some distance apart, and therefore neither the task nor the ground were suitable for a regimental R/T net. Furthermore it is very questionable whether a regimental net would work in the Divisional R.E. The old command net itself was often stretched to its limits, both by the traffic it carried and the distance apart of its out-stations. To take two examples—a division in the pursuit might be operating on one or two roads with its R.A.C. regiment many miles ahead. As Lieut.-Col. Henniker has said, there must be a R.E. officer with the leading troops, but H.Q., R.E. would be in such a position that, even if this reconnaissance officer were on the same net, he would probably be out of range. True his messages could be relayed, but they could equally be re-transmitted with very little extra time spent on a command net. Again, a division might be advancing in contact on a very wide front on a large number of roads. I have had experience myself of 30,000 yards. In these circumstances, too, a regimental net could not work successfully.

To turn to the question of traffic, it was often remarked by Signals that the R.E. command net was the busiest in the division. The conversations that passed were frequently of a planning nature, arrangements to meet some fresh contingency which had just arisen, involving, for example, the transfer of bulldozers and tippers from one part of the front to another, not the short crisp passage of commands in battle. On many occasions one has had to wait one's turn to speak on the net, even when it only had half a dozen out-stations. How much worse would it have been with twenty-five or more. Admittedly our conversations might have been curtailed with a higher

standard of training, but not to the extent necessary for a net of this size. I think myself that this is the most important argument against a regimental net. On the other hand, it is easy to visualize occasions, e.g., a deliberate river crossing operation, when a regimental net might be useful if carefully handled. If so, it could easily be organized.

Requirements

Lieut.-Col. Henniker has clearly stated what his requirements are. Let us now examine these. The leading Sapper officer will probably be with the Divisional Regiment R.A.C. rather than the infantry, at least in the advance. There are three people, who want his information principally—his O.C., the C.R.E., and H.Q., R.E.—and a regimental net would enable them all to get it at the same time, assuming the range were all right. Alternatively, if the C.R.E. had one of his field engineers up in front, as he probably would have, then he and H.Q., R.E. would get their information from that officer on the command net. Nor is this the only channel, as Divisional H.Q. will also get the information on their own command net from the divisional regiment. Again, if the company reconnaissance officer is within range for passing back information on a regimental net, he can also do this by flicking on his 22 set to a command net, where there would be much less traffic, and far more chance of his getting on the air without delay. On the other hand, if the leading officer is out of range, his information will have to be relayed in any case, and this may just as well be done by the company rear link as by any other means. It is questionable whether enough use has been made in the past of flick frequencies.

The O.C. of the leading field squadron requires communications with his squadron, with H.Q., R.E., and with the brigade which he is supporting. Since on the move he will probably be living with the H.Q. of the brigade concerned, he has no problem there. And if conditions are static, the brigade signal troop will almost certainly have connected his squadron to the brigade switchboard, so he has both R/T (using his rover set) and line communications with his squadron. Furthermore, he can and should flick to the C.R.E.'s command net at intervals, which will usually be laid down in orders. Unless he has the Bridging Troop of the Field Park Squadron under command, he will not need communications to it, as he will have to ask H.Q., R.E. for it first in any case. If it is under command it will automatically be on his own net.

Much the same applies to the Armoured R.E. If a detachment is under command of a field squadron, then it will at once come on to the squadron net; or, if a squadron is under command C.R.E., then it will be on the C.R.E.'s command net. There does not appear to be any case for having a regimental net here. The Bridging Troop has already been dealt with. As regards tippers and bulldozers, they certainly have no R/T communications at present, except in the case of tank dozers. If they are to be provided with sets, the problem of operators immediately arises, and this is not easy. But do they really require sets? Bulldozers and tippers are normally allotted direct to the user troop, which has a set, or, if in reserve at squadron H.Q., are equally handy, and orders can be passed to them in either case quite quickly on the squadron net.

As for H.Q., R.E., all Lieut.-Col. Henniker's requirements have already been met with the exception of company reconnaissance officers and the tipper or bulldozer pool. In the case of the former, it has previously been suggested that direct communication with all reconnaissance officers is not necessary. In special cases the C.R.E. will order forward one of his own field engineers. And the tipper or bulldozer pool, if not under command of one or more of the

field squadrons, will be with the Field Park Squadron, and can be got at that way. The C.R.E.'s rover is usually netted as an outstation on his own command net, with the flick frequency tuned to the C.C.R.E. If Divisional H.Q. wish to speak to the C.R.E., they can do so by telling H.Q., R.E. to pass a message.

And finally the Field Park Squadron. On the old scales of wireless sets, communications were definitely unsatisfactory, but this will be remedied as soon as new scales are approved.

Line

Hitherto there has been no cable detachment provided for the Engineers by Divisional Signals, and there can be no question but that such a detachment, providing a switchboard at H.Q., R.E. with facilities for connecting up squadrons, would be invaluable. But the possibility of achieving this most desirable, if not essential, improvement appears to be remote. Although H.Q., R.E. of certain divisions provided their own switchboard and operators in the last war, it is doubtful whether all would agree to this use of the already too limited Sapper manpower. And with Divisional Signals reducing their "N" Troop commitment to that of manning the C.R.E.'s forward control and rear link sets only, there seems little chance of help from this source. But it should be pressed for. The provision of an Engineer switchboard with a line to the C.R.E.'s control set means that any telephone may be used as a remote control, and the G.O.C. or any staff officer at Divisional H.Q. can then talk direct to the C.R.E. on his own net wherever he is.

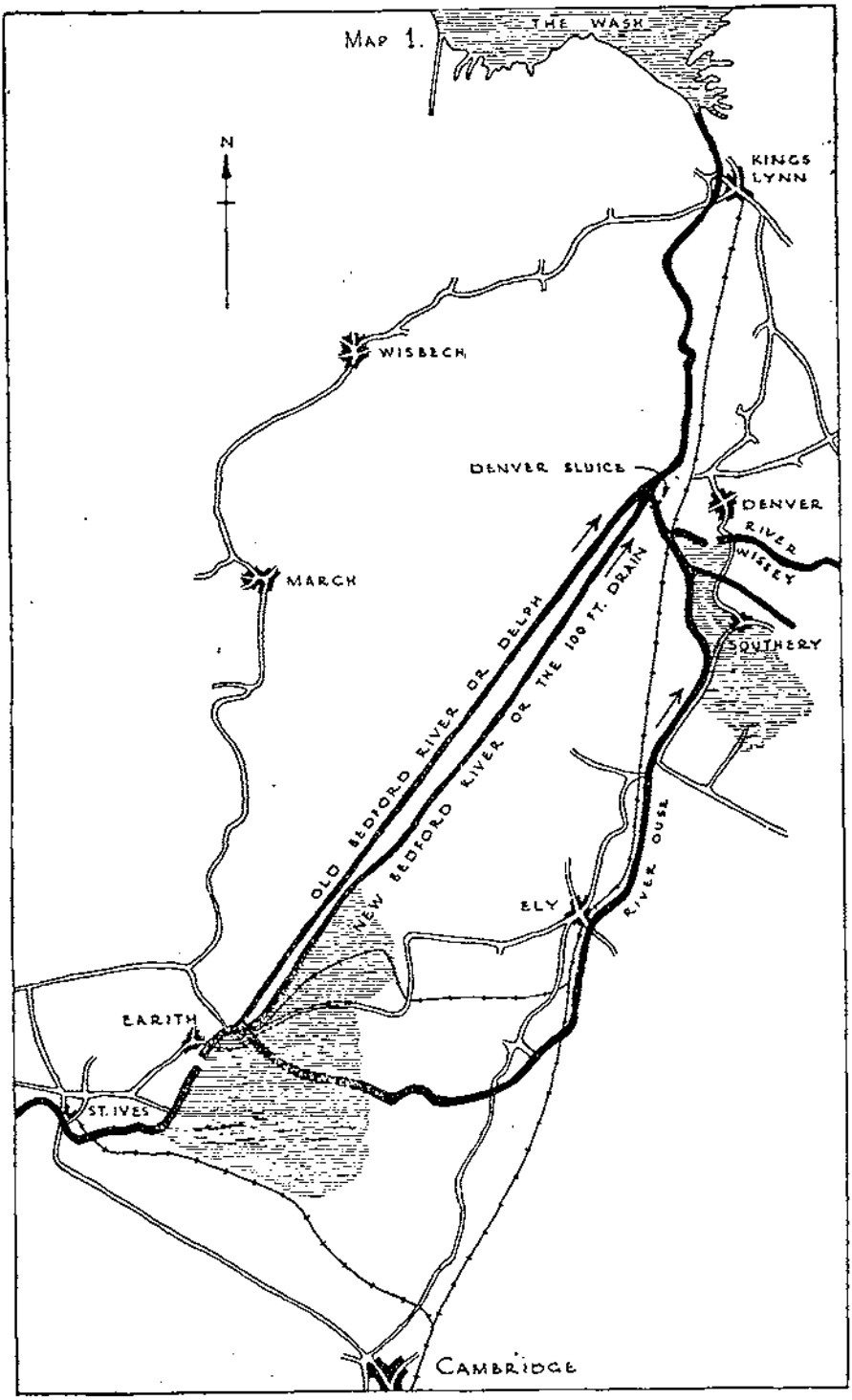
Man-Pack Sets

Lieut.-Col. Henniker has demanded man-pack sets for the reconnaissance officer. They would certainly be of great value in a number of other ways too. One example that immediately comes to mind is for communication between bridge building parties on either bank of a river, particularly at night. Their probable provision when the new proposals are agreed will solve many problems.

Conclusions

In conclusion it may be said that while a regimental net may have its advantages for certain special operations, it would not by any means always be of assistance. Generally speaking it would tend to be far too crowded to allow free working, even with improved R/T discipline and training. Moreover much of the advantage secured by the R.A.C., where a large proportion of sets are manned by officers, would be lost in the R.E., where few sets, if any, would normally have an officer on permanent listening watch. Another disadvantage of a regimental net would be a tendency—possibly unintentional but almost certainly at times irresistible—for a C.R.E. in direct touch with his troops to interfere in the normal chain of command.

Flick frequencies could and should be made more use of, and their proper employment would go far to meet Lieut.-Col. Henniker's requirements. Finally, one cannot help feeling that, where failures in getting back information to H.Q., R.E. were experienced, these were due not so much to an indifferent R/T system, but rather to a faulty use of that system.


MAP 1.
THE WASH
N
KINGS LYNN
WISBECH
DENVER SLUICE
DENVER
RIVER WISSEY
MARCH
SOUTHERY
OLD BEDFORD RIVER OR DELPH
NEW BEDFORD RIVER OR THE 100 FT. DRAIN
ELY
RIVER OUSE
EARITH
ST. IVES
CAMBRIDGE

Map 1

THE FEN FLOODS, 1947

By Brigadier E. E. Read, C.B.E., M.C.

MUCH public attention has been focused on the great disasters that have occurred in the Cambridgeshire Fens, the Lincolnshire Trent Valley and elsewhere in March, 1947. The magnitude of the disaster was great. Many thousands of families were rendered homeless and vast areas of agricultural land were denied to husbandry at a critical time of the year for planting. Standing crops, and stacks of hay, straw and roots were irretrievably lost.

The Army and to a lesser extent the other fighting services have rendered very substantial aid during the worst of the disaster in repair work: rescue work: the provision of stores: and in inspiration. It appears to have become an accepted fact that in any time of national difficulty, the Army is automatically called in, usually totally unbriefed, and most often after the difficulties have occurred; and the public has come to rely upon the Army pulling the chestnuts out of the fire which others find too hot to approach.

It may be expedient to examine how such a disaster occurs, what has to be done at the critical time, and how the nation may get the best help out of its existing civil organizations and from the timely and well considered aid of the Armed Forces.

This article will primarily consider the Fen floods. This area is controlled by one Catchment Board which deals with everything that concerns the River Ouse from above Bedford till it reaches the sea at the Wash below King's Lynn. The true Fen area, which is shown on Map I, starts shortly below St. Ives and except for a few natural islands, such as Ely, Wisbech and March, the whole country from here to the Wash would be normally, if it had not been reclaimed, covered and uncovered by the tide.

The system has been copied from the Dutch, though the copy is not as good as the masterpiece. In general it consists of open ditches up to 4 ft. deep which drain the fields, fens or polders by gravity to a series of larger ditches, or minor lakes, which may be termed "collectors." From these collectors the water is pumped to "bosoms," which are in fact the rivers, which discharge by gravity to the sea. In many cases these bosoms can only discharge at certain states of the tide; and either they are open, in which case the tide comes back up them, or they are closed by sluices, such as the big sluice at Denver, in which case the drainage water to some extent piles up in the bosom through periods of high water. This process can be regulated at the time of pumping if the collectors are big enough to do their stuff. This system is elastic and should have ample reserve. Pumps will seldom need to work for more than two or three hours a day. The water level in the primary ditches can be regulated according to the type of crop being grown, thus for grass it may be 1 ft. down, for corn 2 ft., and for roots 3 ft.

The River Ouse, or the Old West River, was the original line of drainage and is now contained between high banks and runs as a bosom, high above the surrounding country. The River Wissey is similar. The Ouse was found inadequate to carry the total water pumped and was supplemented by the two parallel rivers, the Old Bedford or Delph, and the New Bedford or

"The 100 ft. Drain." These two rivers run parallel about 1,000 yds. apart. Their inner banks are lower than their outer, and this enables the water to overflow into the land, (or "Washes") in between the two rivers and to form one vast wide stream.

Since the introduction of this drainage system with the gradual drying out of the peaty soil, there has been continuous shrinkage and the country gets steadily lower. This may amount to as much as half an inch a year.

The causes of the floods may be attributed to the sum of a considerable number of factors:—

1. In the upper reaches of the river, urged on by public and ministerial opinion, progressive landowners have continuously improved the drainage system of their land. This gives a much quicker run off and consequently makes the river have to carry more water. The capacity of all these rivers is therefore steadily becoming less adequate, as the drainage has been improved both in the high land and in the low land. The reserve remaining for time of heavy run-off is much reduced and there is no doubt that the total cross section available was inadequate.
2. The design of the banks, with slopes often as steep as 1 in 1½, was inadequate, and at times when the banks were full right up to their top the hydraulic gradient fell substantially outside the base. The banks were therefore at the mercy of every manner of seepage, in fact the toes were woefully weak.
3. There were during the war years considerable arrears of maintenance. Erosion by waves, and damage by floating logs joining up with a series of ratholes, might well imperil the whole structure.
4. The patrol system was inadequate for times of danger, especially as regards rapid communications.
5. There had been a continued snow-fall, and there had been the hardest and most continuous frost that had been known for many years. This had quite obviously made the ground hard to such a depth that it was unlikely that the snow could be absorbed into the earth.
6. There were no extra precautions to compete with waves. When very large areas become flooded the action of waves is extremely serious. With every change of the wind an entirely new and unsuspected area is attacked. Quite fragile protection will often be good enough.
7. There was no second line of defence anywhere. Certain potential barriers existed, but their heights were not known relative to the water that might pour down upon them, nor was their strength known, and they all held certain different weaknesses. There was a lack of data and of enlightened reconnaissance.

On the 14th March, water had begun to come down from the Wissey from a weak point which rapidly grew into a breach, and Hilgay Fen was flooded. Two hundred soldiers from an I.T.C. were sent in by request to help sand-bag the road south west of Southery as a second line of defence. The organization of this and other minor jobs gradually drifted the whole affair into becoming a Sapper set-up.

Throughout this time the Catchment Board remained responsible for the whole work. The duty of the Armed Forces was to assist them, under their direction. It was found, however, that the army was able to suggest to the Catchment Board ways in which the troops could be used, and in many cases, methods of construction and types of equipment that appeared to us profitable. It was agreed that the Earith Gap was beyond the powers of the Board. We outlined to them our proposed method of closure and they asked us

The Earith breach.

Photo by Mirror Features.

The Fen Floods, 1947

The Earith breach closed by "Neptunes".

Photo by Mirror Features.

The Fen Floods, 1947 1

to carry it out. This was a completely military operation. At the Wissey Gap the direction and method remained rigidly under the Catchment Board but there were very large numbers of soldiers helping.

On the 19th March the River Ouse burst its southern bank near Earith just before its division into the Ouse and Bedford rivers. In a very short time this had flooded the whole countryside eastwards for an area of 25 sq. miles. The desolation was quite fantastic. Something big had to be done at once.

On the 22nd March an old culvert in the road near Southery broke, and the whole of the Wissey flood waters held by this embanked road swept through the gap, carrying with them a six-roomed house in a few minutes, and a further 25 sq. miles of rich fenland was under water. Some of the floods reached to eaves' level on the houses. Rescue work and navigation were extremely difficult, with floating tree trunks and with hedges, barbed wire fences and walls sticking up all over the place. It took me with two Dukws, both with experienced drivers, over two hours to get across the southern flood.

Immediate attempts were made to limit the size of the Earith gap by driving sheet piles at the cheeks, but the progress here was far slower than the gravity of the situtation warranted. Similarly at the Wissey gap little was done for some time to make a serious effort at holding. Ample sand-bagging with clay at this gap was all that was required. The importance of immediate action to hold what you have got must be stressed.

The technique of closing a gap embodies certain fundamentals. Water is an extremely revengeful enemy, and if it is thwarted in its purpose it will find another and more devastating way to attack. It is necessary to disillusion oneself entirely from the idea that everything firm that one can get into the gap is something to the good. This is the opposite of the truth. Everything firm that you get into the gap is in fact, an added danger, since it forces the water into more limited channels at greater speed, and renders them more than ever liable to erosion. It is necessary from the very start to make good the two cheeks of the gap, thereafter a firm bottom must be obtained by sinking brushwood mattresses, Sommerfeld track or by torpedo netting. From then onwards, the cheeks can be pushed inwards and the bottom built up with stone and other heavy material until a point is reached when neither sides nor bottom will hold any longer and a "snap" closure in one operation becomes necessary. If the cheeks are pushed in the scour on the bottom becomes too great. If the bottom be lifted up too much, the overflow becomes too great and there is scour where the water falls. This should be provided for from the start by carrying the mattresses a very long distance out. This distance may be as much as two to three hundred feet. It is important that filling material of the greatest possible specific gravity should be chosen. Stone, clay in sandbags or sacks, boulder clay, chalk and foundry slag, may all be used, the heavier the better. It should be of S.G. not less than 2 and preferably exceeding 2·5. For very difficult jobs basaltic rock of S.G. 3·0 is necessary.

It is absolutely essential therefore that the final closing be done in one single operation in a matter of minutes. If a ship be used, it is necessary to bring the cheeks to such a point that the ship will fit against them, or if the river is very narrow, will fit into rebates. It is often possible to get firm cheeks out to the right length by sinking two small ships, one for each door post ; door posts must be firm and not liable to erosion. It will seldom be possible to find a ship of the requisite length that is high enough. Much work will therefore be necessary on bringing the firm bottom up. If this is not possible to the degree of height needed, it will be acceptable to put in a ship and let the water

spill over it. The ship is unlikely to erode but care must be taken that the bottom on to which the water spills, is well filled up with mattresses and stone. A second ship can then be put in as a further operation. It is advantageous to use steel ships as, when blown up, steel ships often break their backs and settle well on any unevenness in the bottom. All ships must be as heavy as possible in order not to be swept away and should therefore be pre-loaded with heavy filling to the maximum amount that will still enable them to float into position. Two holes, each 2 ft. square, are enough to sink ships up to 200 tons in three or four minutes. Alternative charges should always be laid in the opposite corners.

On the evening of Sunday the 23rd March, it became apparent that this immense devastation could no longer be regarded with complacency, and an immediate closure at Earith was necessary (See Fig. 2). A cross section of the gap is shown at Fig. 3. I would have preferred to have mattressed the bottom here, before attempting to close, but there was no brushwood cut and no mattress makers available. With the current of about 3 knots in the gap it would have been just possible to sink such mattresses. Neptunes (an improved form of Buffalo with higher sides) weighing about 16 tons, empty, were available and we therefore decided to close with Neptunes on Monday evening. This gave extremely little time for rehearsal, in fact I had not realized the full difficulties of the special drivers who had been sent down. They were relatively inexperienced and the vehicles were difficult to drive and had been a long time in store. The whole river was a vast sheet of water and it was very hard to know, even from local officials, where the banks existed under the flood. Inside the river there were, in fact, many of these, some so high, that even storm boats grounded. This brings out abundantly the very great importance of getting a survey of the gap and the bottom made at the very earliest opportunity. This survey is the basis on which all the closing plans are made.

There was a line of apparently shallower water. (Fig. 3, C and D). We proposed to station two anchor Neptunes at C and D to hold the closing ships laterally to prevent them being swept through the gap. I also proposed to station one Neptune upstream and one downstream as anchors at E and F, using their winches to pull closing Neptunes up or down if they had got out of position. These precautions are most necessary and it is always best to over insure in the matter of anchors. In actual fact, just before the closing, a bank was found at G—G with some osiers sticking out, on which it was calculated that the Neptunes could walk, provided they were pre-loaded with 5 tons ballast, and this is what we actually did.

I was extremely worried about the possibility of scour through the triangles between the bows and sterns of successive Neptunes and underneath between the track rollers. Elaborate precautions were made to deal with these instantly before the scour took charge. We calculated that about 60 tons of sand-bags were needed to fill these gaps. I doubled these on cheek X and placed a further 60 tons at cheek Y. The latter had to be ferried in swimming Neptunes to the side and unloaded by hand. I had to insist on this. It is necessary to work from every conceivable access point at the critical moment to get the filling done quickly. In addition a further 300 tons were being filled and working up a rather rickety L. of C. (See Fig. 2). This L. of C. occasioned in itself a good deal of engineer work. Sand and clay were dumped on the main roads outside Earith station. Here they were filled into bags by a continuous working party of 100, later boosted to 250, working day and night for three days. They were then loaded on to lorries and ferried to the station yard and unloaded on to railway flats. These were pushed up the broad

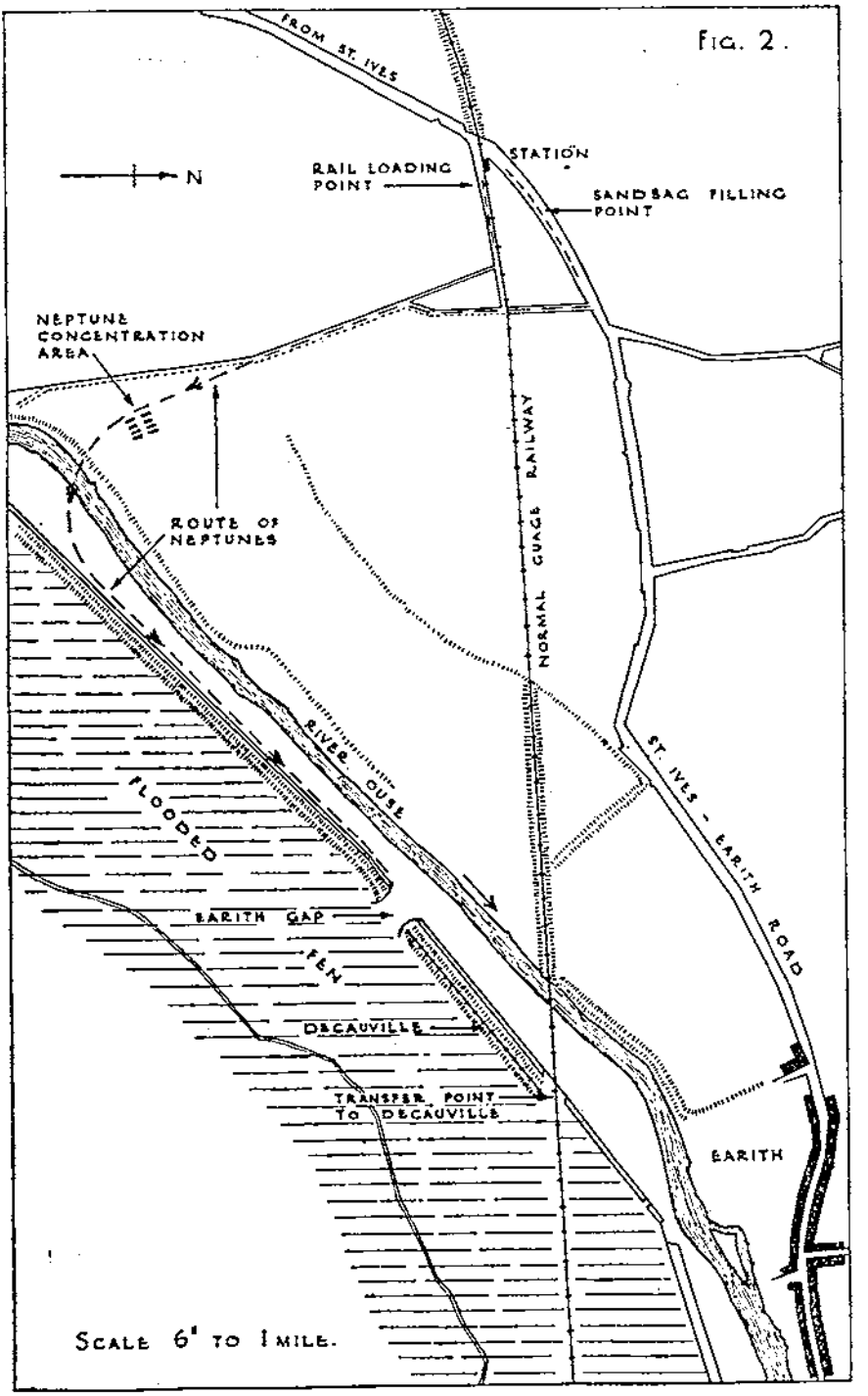


FIG. 2.
FROM ST. IVES
N
RAIL LOADING POINT
STATION
SANDBAG FILLING POINT
NEPTUNE CONCENTRATION AREA
ROUTE OF NEPTUNES
NORMAL GUAGE RAILWAY
RIVER OUSE
FLOODED
ST. IVES - EARITH ROAD
EARITH GAP
FEN
DECAUVILLE
TRANSFER POINT TO DECAUVILLE
EARITH
SCALE 6" TO 1 MILE.

Fig. 2

gauge railway line till it dipped into the water just over the Ouse railway bridge. Here a shoot was arranged and two lines of Decauville track half a mile long were laid along the bank to the gap. Simultaneously some bags were loaded into storm boats and taken in the fen flood to the further cheek Y. The preparation of these reserves and the rehearsals drew the time out to 20.00 hrs. on Monday the 24th.

Meanwhile about 18.00 hrs., the Neptunes had been formed up outside Earith station (See Fig. 2) and started across the fields and began to swim the river about three-quarters of a mile upstream, in order to avoid any risk of being swept through the gap. It was the intention that they should swim over and come down along the line G—G and form up at H for a simultaneous act of closing. However they broke down or got stuck all over the place and I had to go round in the dark in a storm boat putting R.E.M.E. fitters and selected drivers on to the stranded Neptunes. They eventually got formed up about 23.00 hrs. During the process of this forming up, all the Neptunes had got out of order. There were so many derelict Neptunes that we had lost our reserves and the two anchor Neptunes, and the up and downstream anchor Neptunes. However, the experience of driving down this submerged bank gave me confidence that we might be able to do the job without floating.

The closing of the gap then began. First the cross Neptune was put in at the downstream end. This was wholly in the water but we felt underneath it a small ditch, 2 ft. deep and 3 ft. wide, which we had previously plugged with sand-bags. When the closing of the gap actually started, this ditch almost immediately scoured out to a depth of about 10 ft., and became a great point of danger. As soon as this marker Neptune was in position we fired a Verey light with the intention that the whole eight Neptunes remaining should steam straight into position. At the critical moment of starting the middle one konked. They were so tight nose to tail that it was quite impossible to extricate this one. We therefore ordered them to drive on, and in fact this dead Neptune was pushed for nearly 150 yds. absolutely true into position. This took about one minute. The cross Neptune at the upstream end, driven by a very skilled R.A.O.C. officer, then put itself into position completing the closure. This officer rocked his tank backwards and forwards and actually settled down to the bottom of the unseen ditch and there was no scour on this side. On each of the Neptunes we had prepared Sommerfeld track to cover the triangle, with an upturned toe to be held down by the sand-bags. In addition there was a rather complicated corner piece, which was in practice most difficult to launch. On asking whether everyone was ready to cast this netting, it was found that one piece had gone astray. It was snowing hard but the area was illuminated by the glare of searchlights on the high ground. A Sapper Sergeant immediately took off his clothes to go in and find the lost net. Fifteen dangerous minutes were lost during which anything might have happened. Fortunately the water rushed safely through the open triangles. At a given signal the nets were lowered and immediately afterwards, tarpaulins to cover them. This had absolutely no effect on the amount of water going through, which was rather mysterious and to some at any rate, disquieting. On each Neptune we had piled one extra ton of sand-bags as an immediate reserve for casting, and they were each manned by twenty men under an R.E. officer. These bags were immediately cast overboard on to the netting and tarpaulins, and three chains of men passing the sand-bags from the two ends were organized.

The follow-up went on at high speed. All this had been done in a matter of minutes. Since the bags were cast over at random, there were many irregularities. The junctions of these were a great cause of trouble ; it would

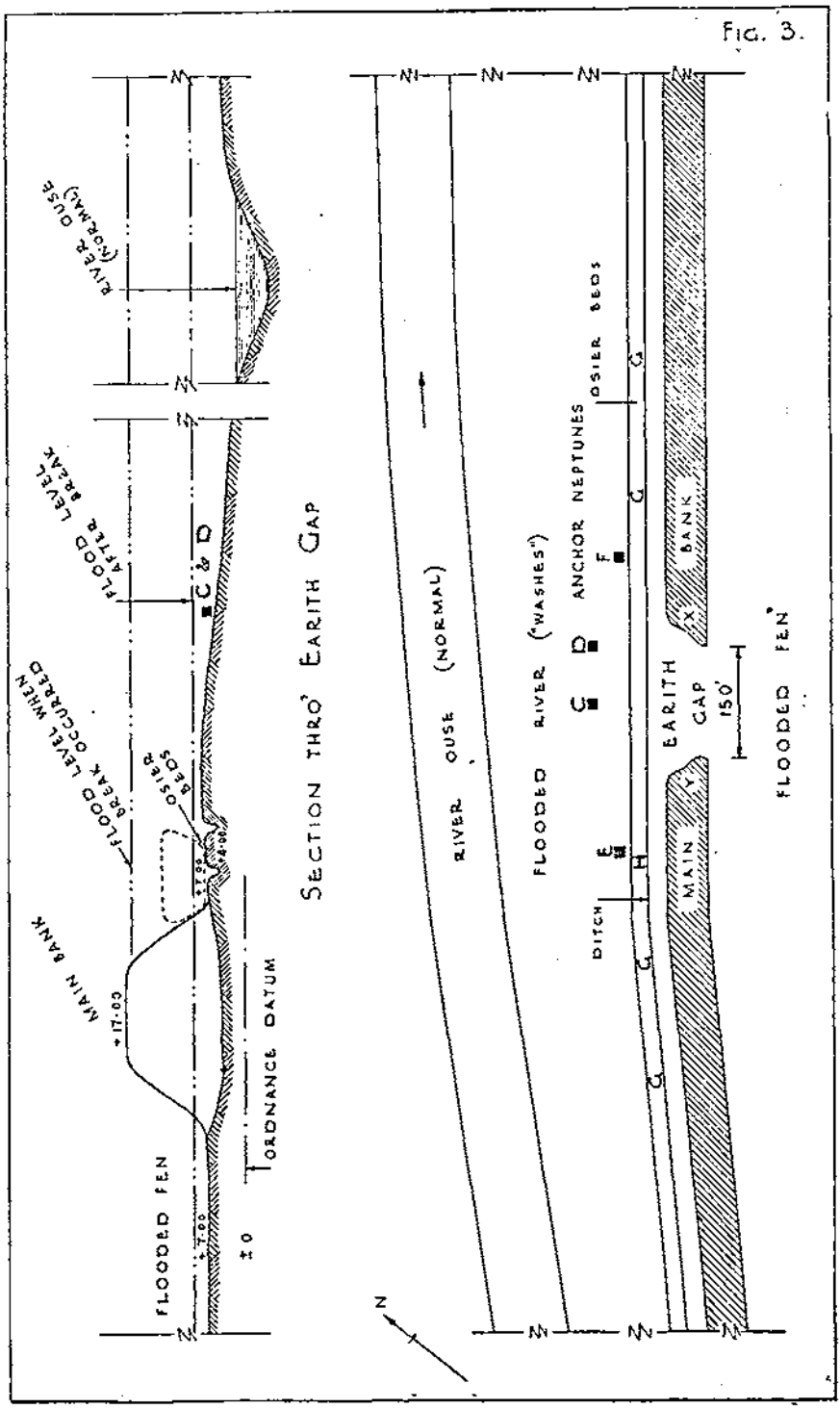


Fig. 3.
SECTION THRO' EARITH GAP
RIVER OUSE (NORMAL)
FLOODED RIVER ("WASHES")
ANCHOR NEPTUNES
OSIER BEDS
EARITH GAP
150'
MAIN BANK
FLOODED FEN
FLOOD LEVEL AFTER BREAK
FLOOD LEVEL WHEN BREAK OCCURRED
MAIN BANK
ORDNANCE DATUM
FLOODED FEN
DITCH
C & D
N

Fig. 3

have been better, could we have done it, to lay the bags to some reasonable pattern and bond. About 03.00 hrs. the fatigue of all was intense, and it became necessary to organize short shifts of half an hour, actually slinging bags. There were never enough bags and we had soon exhausted the whole of our reserve, and were living on the bags coming up our L. of C. Further shifts were then laid on at once by getting more infantry from the depot for laying, and 300 more Germans from Agriculture for filling and humping. These men were to start at 07.00 hrs. and to keep up, and increase, the tempo of placing sand-bags. By dawn, clay had begun to arrive and we were able to throw in the much more satisfactory clay-bags, and were able to stand on the wall, now touchable under the water, and to lay our bags more regularly. This tempo had to be kept up for three days, and one cannot exaggerate the importance of a terrific follow-up for any closure with bags, stones, and possibly torpedo netting.

Meanwhile at the Wissey Gap (See Fig. 4), they had succeeded in making firm the cheeks, though not before some ground had been lost. The river here was very narrow. This gap might have been closed by a ship but no suitable ship could be found. Hopper barges were brought up with clay but they refused to " hop," and it is clear that for the use of clay or stone straight-sided hoppers are needed. I think that in this case we ought to have tried a few sticks of gelignite in the clay to persuade it to go through. Foot-bridges and access work were done by the R.E. It seemed that if we wanted to get a move on at this gap, by hook or by crook, we ought to get a crane or grab on the site. Unloading bagged clay was fairly primitive, and every day the ruin caused by the floods was increasing. Meanwhile at least 200 men plus searchlights, were trying to raise the level of Sam's Cut in order to reduce the difference in head. Although the water was spilling over here, it did have a very useful effect in keeping the difference in head between the Wissey (up which incidentally, the Ouse was flowing backwards), and the Fen immediately outside the gap, at not more than 3 ft. However no grab was brought to site either by raft or barge. Mattresses had been made at Denver and were towed up the river and put in as reinforcement mixed with the bags and also to prevent the overflow from scouring further. This primitive work went on for ten days, and when the sandbags eventually appeared above the water the whole crest burst. It was finally closed 24 hrs. later. This was a case where a ship such as a 40-ton barge might well have been put in much earlier.

There were many other arms besides the R.E. who contributed materially to this assistance. A.A. Searchlights were invaluable. Artificial Moonlight was tried using a 90 cm. projector at maximum dispersion. It was not a real success and we had to revert to relatively concentrated beams. In addition Lyon lights were set up actually on the gaps.

The R.A.F. were able to provide considerable lighting assistance. The mobile aerial beacons were invaluable when they could get close enough to a job. There were also various forms of sodium lighting and other lighting used for night landings, which were useful for covering such areas as sand-bag filling and laying.

The lighting seemed to happen of its own accord and wherever there was a big work going on by night, A.A. Artillery and R.A.F. did something about it.

R.A.S.C. driven amphibians were used to exhaustion, not only for rescue work but in keeping the repair work going. Neptune drivers were provided by R.A.S.C. R.A.O.C. parks produced many of these strange vehicles which had not been in use for some considerable time and also usually produced drivers to get them there. Their allied R.E.M.E. teams were invaluable as the drivers were new to the vehicles which had also been in store for a long time, and the casualties were considerable.

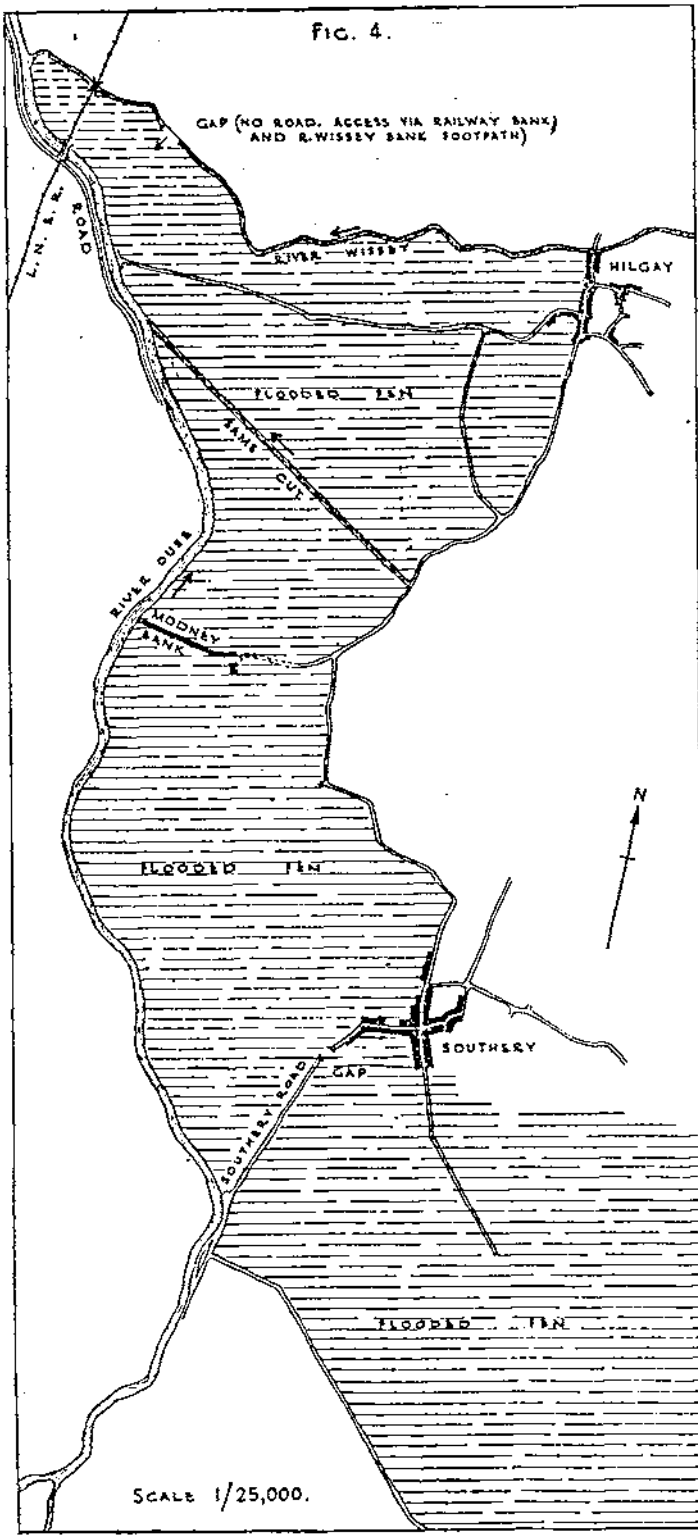


Fig. 4.
GAP (NO ROAD ACCESS VIA RAILWAY BANK AND R. WISSEY BANK FOOTPATH)
L.N.E.R.
ROAD
RIVER WISSEY
HILGAY
FLOODED FEN
RAMP CUT
RIVER OUSE
MOONEY BANK
FLOODED FEN
N
SOUTHERY
GAP
SOUTHERY ROAD
FLOODED FEN
Scale 1/25,000.

Fig. 4

Sand-bag filling was done by young soldiers from I.T.C.s, by trained men who were in passage through the R.A.S.C. Depot, and by many other odd detachments. The R.E. units were all B.D. companies, over seventy per cent German. These Germans were virtually used as British Sappers, and worked extremely well. Conversely the Germans brought in from Agriculture, who had long been out of touch with discipline, worked extremely badly, and once, but definitely only once, refused to work.

Many Service detachments seemed to arrive of their own accord and rally round the jobs. This was how the first Neptunes came and also the R.A.F. landing lights, and a great deal of the Services' effort seemed to come through unorthodox, but nevertheless satisfactory channels.

Very large military stores had to be ordered on pure speculation. Half a million sandbags, 400 ft. of Bailey, 1,000 f.r. of kapok, 40 tons of torpedo netting, Sommerfeld track, storm boats, and a host of tools, cordage and minor stores.

It may well be asked what might have been done which was not done. It must be accepted that the scene was definitely set for a possible disaster and it is suggested that reserves of every kind might have been drastically reviewed. On occasions of flood, many sectors of road and of river are cut off, and much could have been done to position tugs and barges so that all sections were accessible. Reserves of stores might have been distributed to accessible sites, and stocks in depots and in the hands of suppliers might have been earmarked. The progress of the waters and of the work in hand, might well be watched in order that warning can be given where assistance is going to be required before it is too late. Most of the stores and most of the men were ordered up by the Army on intelligent guess work.

It may be useful to consider the tasks upon which the Services might be best employed to the advantage of their own training, and of the nation. It would appear that the most satisfactory assistance would be in provision of facilities which do not exist in civilian life. The use of the services for other purposes, must to some extent, reflect on the excellence, or otherwise, of the organization which has called for their aid. The tasks upon which they might most profitably be employed appear to be the following :—

1. The earmarking and later provision of those stores which the civil organizations have decided cannot be made available anywhere on the civilian market in time. It is possible to think this out well before the stores are needed, and the Army itself should be given a chance to make its own arrangements for provision action.
2. In the case of a complete break-down in civil methods of earmarking labour and transport throughout the country, the army might help, but it is difficult to see why this should be necessary.
3. The provision and manning of L.C.M.s or similar craft for rescue work and for movement of repair equipment to inaccessible sites. This is at present a Royal Marine commitment.
4. The provision of wireless and R/T to help intensive patrolling during danger times.
5. The provision of searchlights, landing lights and beacons, Lyon lights, and all illumination at points where night work becomes necessary.
6. The provision of vehicle bridges and foot bridges to sites which have been made inaccessible by floods. The construction and operation of rafts, ferries and stormboats. In very exceptional cases the operation of mechanical equipment which cannot be found by contractors. Demolition work.
7. The operation of all types of amphibians both for rescue work, and for service at gaps.

DEVELOPMENT OF I.W.T. ON THE RIVER CHINDWIN 1945

By Lieut.-Col. D. C. Merry, R.E.

General Note

THIS article was written after a visit to Kalewa and a journey down the River Chindwin in mid-April, 1945. Concluding paragraphs have since been added outlining the further progress which was achieved between mid-April and the end of June when the craft construction site was finally closed down.

Introduction

1. The conception of the British I.W.T. barge line on the River Chindwin can be traced back to the days of May, 1942, when the last of General Alexander's forces crossed the river and struggled out into India. It was foreseen by some, even in those days, that a considerable portion, if not the whole of the Army which would liberate Burma might re-enter the country by this same route, along which our forces had withdrawn.

2. The fundamental problem, however, would be to establish adequate overland communications through the wild and undeveloped terrain of N.W. Burma. Land communications then, as now, were poor and undeveloped in this frontier region and were greatly influenced by the heavy monsoon prevailing in the area. In these circumstances, the broad navigable waters of the Chindwin were the natural artery of communication and provided a ready-made L. of C. from the Chin hills into the plains of central Burma.

3. To use this waterway would involve bringing all the craft and equipment from Manipur Road, the nearest railhead, along the 300 mile road L. of C. through Imphal and down the Kabaw Valley, itself the most undeveloped portion of the L. of C., to Kalewa. It was essential, therefore, that the equipment should be so designed that it could be carried in small components over these difficult roads. This consideration led the War Office to design barges and tugs called Unicraft, steel craft made of thin $\frac{1}{8}$-in. plates riveted together with $\frac{3}{8}$-in. rivets. All the components of these craft are light and easily portable, the heaviest being the engines of tugs, which weighed 17 cwts., and the bow section of the tugs which weighed 7 cwts.

4. These craft were manufactured in England. Difficulty was experienced in obtaining the necessary release of steel and manufacturing capacity to permit any production in the early stages, but by October, 1943, pilot models had been produced and were being erected for trials at Lowestoft at the very time when South East Asia Command was being formed. Production went ahead, though still subject to delays, and by the end of 1944 and the beginning of 1945, after nearly 3 years, enough of the craft had been produced and were available in India to make possible the development of the L. of C. as the Fourteenth Army began its victorious campaign for the liberation of Burma. That they arrived only just in time after three years of preparation must remain a lasting tribute to the forethought of those who designed and obtained production of these craft.

Development of the Plan

5. When the campaign for the liberation of Burma was being planned in the Summer of 1944, it was not at first thought that the Chindwin River

would prove the essential L. of C. artery, which it in fact became. The campaign as then conceived did not envisage the sweeping success and rapid advance south which it finally took, but a more limited drive in an easterly direction towards the Shwebo Plain. Thus the Chindwin lay off the contemplated axis of advance and tended to take second place in the thoughts of those planning the campaign.

6. Nevertheless, it was foreseen by others that use of the Chindwin would be certain, whatever the course of operations. Some equipment was therefore prepared in India for forwarding when necessary. In addition, late in 1944, when the monsoon had ended, a trial was carried out of taking craft by road from Manipur Road to the Chindwin. One Ramped Cargo Lighter was transported in this manner, together with one or two smaller craft and erected on the banks of the Yu River, South of Tamu. They were launched with the aid of elephants and floated down on to the Chindwin. This experiment proved the feasibility of carrying by road, craft which were in fact larger than Unicraft, and thus the main obstacle to the development of a barge line was successfully overcome.

7. The final stage came at the turn of the year, when the rapid and successful advance of the Fourteenth Army opened the prospect of the liberation of all Burma in 1945. The urgent need then arose to develop lines of communication not east, but south, and the full significance of the Chindwin was realized. Orders were issued for the most rapid development of an I.W.T. service, starting at Kalewa and extending down the river in accordance with the progress of operations. The first target was set at 100 tons/day from Kalewa to Alon near Monywa. This was soon dwarfed and requirements quickly rose until a final target was set at 700 tons/day from Kalewa to Myingyan, a distance of 240 miles, involving an average turn round of the craft of approximately twelve days. This target was to be reached by mid-May.

8. The first reconnaissance of the craft construction site at Kalewa was made on 23rd December, 1944. Craft construction began soon after and increased in scope and volume as resources became available. The barge line operation began on 1st February, 1945. The following paragraphs describe the types of equipment in use and the progress in construction and in operation of the craft. Progress is detailed up to mid-April, that is, one month before the target date for the delivery of stores at 700 tons/day from Kalewa to Myingyan.

9. By mid-April great progress had been made towards the attainment of this target. It was unfortunate, however, that the requirement to develop the barge line came so late. This sudden decision and the rapidly increasing target meant that the necessary preliminary detailed planning for construction of craft and, more especially, for moving craft components, tools and equipment to the site, was hastily done. Frequent adjustments were necessary and improvisations had to be freely undertaken This, coupled with the distances and difficulties of getting material to the site over roads which were also carrying the other needs of the Army, resulted in delays and unbalanced arrivals of equipment in the earlier stages. These problems were tackled and mainly overcome, largely assisted by supplementing the road communication to Kalewa by additional delivery of men and material by air. Without this assistance from air supply, there is no doubt that such progress could not have been achieved.

Equipment

10. The equipment which was planned for this project comprised the following main types of load carrying craft:—

Photo. 1.—Unicraft Barges at the construction site.

Photo. 2.—Typical tow. Single screw Unicraft Tug and two Barges.

Development of IWT on the River Chindwin, 1945

Photo. 3.—Typical tow. R.C.L. and two Higgins Barges.

Photo. 4.—Raft of Eastern Army Boats loaded with Bitless.

(*a*) *Unicraft Barges* (see Photo 1). Steel riveted craft 60 ft. long and having a capacity of 35 tons at 2 ft. 6 in. draught.

(*b*) *Unicraft Tugs* (see Photo 2). Two types were being built—a single screw tug, having one 40 h.p. engine, and a larger twin screw type with two such engines.

(*c*) *Higgins Barges* (see Photo 3). Flat topped wooden barges 60 ft. long, which will carry a load up to 60–70 tons at 4 ft. draught. During the dry season it was not possible for these barges to be fully laden.

(*d*) *Ramped Cargo Lighters.* Ramped wooden craft carrying up to 25 tons of stores. They are 52 ft. long with a draught of 2 ft. 6 in., and are powered by two 85 h.p. engines.

(*e*) In addition, there were various launches and small craft, powered with outboard engines, for towing rafts and empty craft for terminal and communication duties and for river conservancy.

11. The total number of major craft to be completed were :—

Unicraft Barges	..	135
Unicraft Tugs	..	95 (including 45 twin screw)
Higgins Barges	..	100
R.C.L.s	..	50

12. Although the I.W.T. lift was being principally provided by the major craft described above, various methods were also being used to supplement the lift. These were :—

(*a*) *Eastern Army Boats* (see Photo 4). Alongside the Transportation organization for craft construction, other Engineer units had been building craft known as Eastern Army Boats, made from local teakwood. These are pontoon shaped craft, 40 ft. long, and were originally developed for ferrying and bridging in the Arakan in the earlier days of the campaign. The craft at Kalewa were made up into rafts each of three boats with Bailey decking or Pierced Steel Plank. Each raft could carry a load of 30 tons.

The "factory" for producing these craft was located some few miles north of Kalewa and was run by 536 Artisan Works Coy., R.I.E., who had had previous experience of constructing them. They were assisted by two Forestry companies. and a Workshop and Park company and by native tradesmen. In all, about 1,100 men were employed on this site when production was in full swing.

Between 19th January and 2nd May some 540 boats were built and handed over to the Transportation Service.

(*b*) *Native Rafts.* These were made up of bamboo and were of two types. In one type eighty P.O.L. drums were lashed together and the rafts were decked over. Flotation was largely produced by the P.O.L. drums themselves. In the other type the raft was built up of bamboo with a tarpaulin well in the centre in which cargo could be stowed. Rafts were manned by a native crew of four.

(*c*) *Salvaged Craft.* An organization was set up for salvaging craft, both on the Chindwin and Irrawaddy, and large numbers were salvaged, particularly in the Mandalay area, where the former Government slipway and workshops had been put into operation again with civilian labour. Some of these craft were large tugs and 700-ton barges, invaluable for subsequent I.W.T. operations on the Irrawaddy, but at that time their draught was too big for operation on the Chindwin, apart from the problem of towing power. Towing power was the crucial factor in bringing these salvaged craft into operation. As many outboard engines as possible, together with other marine engines, were flown into Central Burma for fitting to captured

Japanese pontoon craft in the case of smaller engines and 100-ton barges in the case of larger engines. 100-ton salvaged barges were also used with Unicraft towing power.

Craft Construction

13. The craft described in para. 10 above were all constructed at Kalewa. Owing to the distances and time between depots and the erection site, most careful planning and co-ordination was essential to ensure balanced deliveries of craft components, tools and other materials. Many difficulties were met in earlier stages, but a smooth flow of stores was eventually established. Having regard to the physical difficulties and to the lack of time for adequate preparation of the project, this was a creditable achievement.

14. The Transportation units engaged in craft construction were under centralized control at Kalewa. Apart from the fitting out of tugs and maintenance of existing craft, the labour, which included pioneer assistance, was pooled, metal tradesmen being employed in the construction of Unicraft and woodworkers in the erection of Higgins Barges and Ramped Cargo Lighters. Progressive methods of construction were used as far as possible. This applied particularly to the Unicraft, which were built in three stages.

(*a*) Component Sections were fabricated.
(*b*) The whole craft was assembled and bolted together.
(*c*) Riveting was completed and the craft launched.

15. The major operation in the construction of Unicraft was the riveting. Each barge contains about 9,000 $\frac{3}{8}$-in. rivets. At the time riveting was going on at an average rate of about 38,000 per day, or 500 rivets per riveting gang, representing a rate of about one rivet per minute for each gang.

16. The rate of craft construction had been geared up to production of three Unicraft barges per day and two twinscrew Unicraft tugs. Higgins Barges and R.C.L.s were being produced at a rate of 10 to 11 per week, although there had been a temporary hold-up in erection of R.C.L.s, due to non-availability of tank transporters to bring in some of the sections. The following table shows how craft erection had progressed up to mid-April :—

Type	*Total to be built*	*Jan.*	*Feb.*	*Mar.*	*1–15 Apr.*	*Total*
(i) Unicraft tugs (single screw)	50	4	6	26	12	48
(ii) Unicraft tugs (twin screw)	45	—	—	—	6	6
(iii) Unicraft barges ..	135	4	12	22	27	65
(iv) Higgins barges ..	100	—	4	31	18	53
(v) R.C.L.s ..	50	—	9	7	—	16

I.W.T. Operation

17. As stated in para. 8 above, the target for the I.W.T., L. of C., between Kalewa and Myingyan had been set at 700 tons/day by mid-May. Provided the remaining craft construction programme was not delayed by weather conditions or non-arrival of craft components and that engines for salvaged craft came forward at a satisfactory rate, it was expected that this target would be achieved, although full completion might be delayed by some two weeks.

18. By mid-April a daily tonnage of about 300 tons was being lifted down river to Myingyan. On one day a tonnage of over 700 tons was actually loaded. The build-up of traffic on the river since the L. of C. opened is shown below :—

Service	Average tons per day			
	Feb.	March		April
	1–28	1–15	16–31	1–15
Kalewa—Alon ..	96	151	206	—
Kalewa—Myingyan ..	—	—	320*	294
Alon—Myingyan ..	—	—	—	136

*26–31 March only.

19. Traffic was loaded and discharged at riverside ghats, which consisted of Eastern Army Boats or Pontoons with a bay of decking connecting with the shore. One barge could lie against each ghat. At Kalewa, traffic was called forward to the river bank by Movement Control from a marshalling area in the rear. There were three loading areas ; one for heavy lifts, which was also the terminal for the river ferry to Shwegyin, one for general stores, and, on the east bank of the river, a separate loading area for P.O.L. From one to three days' stockpile of stores was usually available in the loading area.

20. At Myingyan, the discharge terminal 240 miles down river, cargo was off-loaded at ghats and cleared by M.T. into depots in the advanced base area some three miles away. No difficulty or congestion occurred in clearing cargo.

21. Stores were loaded and discharged at both terminals by stevedore labour and pioneers. Hitherto there had been no mechanical equipment to assist, except for one crane at Kalewa. Additional cranes were being provided which should do much to step up the rate of handling stores, particularly heavy lifts. On the average, the labour available was handling between 1–1½ tons per man per day.

22. Traffic proceeded down river in standard tows, of which the following are some typical examples :—

Tow	Pay Load
(*a*) One Unicraft S.S. tug towing two Unicraft barges	70 tons
(*b*) One Unicraft T.S. tug towing four Unicraft barges	140 tons
(*c*) One R.C.L. towing two Higgins barges..	125 tons

Allowing a crew of four men on each Unicraft tug, five on an R.C.L. and one on each barge, the pay load worked out at about 18 tons per man.

23. The rafts of Eastern Army Boats carrying thirty tons and the native bamboo rafts, each of which was loaded with eighty barrels of P.O.L., were normally run free downstream, although occasional Eastern Army rafts were towed by a launch with outboard engine, according to the nature of the cargo.

24. Traffic was controlled from four control points which had been established at Kalewa, Alon, Thindaw and Myingyan. There was a further control point at Mawlaik, upstream from Kalewa, where observations were taken of the level of the river. The control points were at that time connected through normal military telephone exchanges which made intercommunication slow and difficult. To improve this, effort was being made to establish a direct telephone line connecting control points or alternatively to establish wireless communication between them.

25. The level of the river and the exact course of the channel, particularly during flood time, is subject to constant change. During the low water season especially, the channel must be carefully surveyed and buoyed. To do this, river conservancy parties were stationed at various points on the river,

including the control points mentioned in para. 24 above. Buoys consisted of bamboo poles painted red for the port hand and white the starboard hand when proceeding downstream. In upper reaches of the river near Kalewa, these marks consisted of stakes with a wooden cross fixed on for the port hand and a bundle of brushwood for the starboard hand.

26. Craft construction continued on the original site at Kalewa until the end of June although certain units had been transferred to Rangoon before that date. By this time the following craft had been completeed,

Unicraft tugs, single screw	50
Unicraft tugs, twin screw	45 (although 22 awaited tailshaft assembly)
Ramped Cargo Lighters	45
Unicraft barges	129
Higgins barges	97
Seamules	15

In addition, a number of outboard motors and other marine engines had been installed in captured craft.

27. Although a shortage of crews for powered craft continually prevented full exploitation of the available I.W.T. lift, the following tonnages were moved during the period April to June —

Month	*Average Tons/Day*
April	413
May	620
June	593

In addition, tonnage amounting to 5,000 tons in April and 10,000 tons in June was carried between various other terminals on the Chindwin and the Irrawaddy.

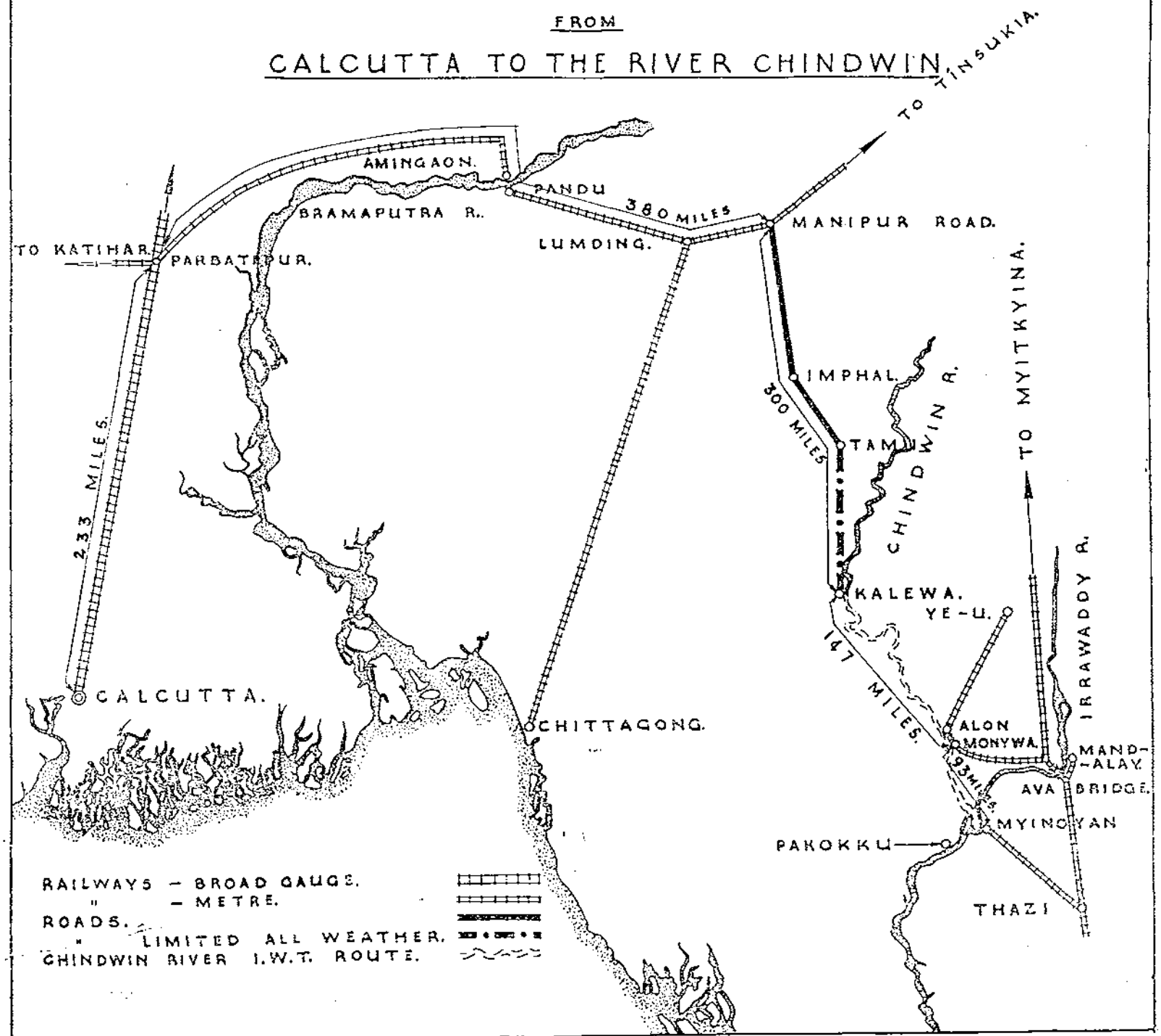
Conclusion

28. This concludes a brief story of the development and operation of the barge line on the River Chindwin, which helped to supply the Fourteenth Army in Burma. To bring the equipment to the river over so many miles of poor roads, to erect it all and put the craft into service had been an achievement seldom attempted on this scale. Great credit is due to all those who, by early forethought in design and production of craft, and by energy, enthusiasm and improvisation in carrying out the project had gone so far to the successful completion of the task which was set them.

DIAGRAM OF COMMUNICATIONS

FROM

CALCUTTA TO THE RIVER CHINDWIN



FLOOD RELIEF OPERATIONS IN NORTHERN COMMAND

By Brigadier W. D. M. Christie

" When the waters came up for an extra monsoon
It is all one said the Sapper."

Kipling.

NOT a great deal of publicity was given in the London press to floods in the north of England and this was perhaps natural, partly because it was the North and not the South, and also because the floods in East Anglia occurred first and by the time they came up in the North they had ceased to be red hot news. However, a great deal of varied and interesting work was carried out by the Corps, particularly the S.M.E., Ripon, and the O.C.T.U., Newark. In this article it is not proposed to go into the technical detail of the many interesting works carried out by those two schools, who, it is hoped, will write an account of their own experiences. It is thought, however, that the general picture of the flood problems and the means taken to deal with them at Command Headquarters will be of interest to readers of the *Journal*.

York

Operation " Noah's Ark," to give it its official title, began to affect Northern Command during the third week in March when demands for the supply of sand-bags for filling breaches and boats for rescue work began to arrive. It was fairly clear even then that an enormous demand for sand-bags might have to be met and when at an Administrative Conference, an officer of another arm suggested getting in a reserve of 10,000 of them he seemed quite surprised when the Engineer representative added two noughts to his figure. The Command fairly quickly ran through its own stocks but received very promptly hundreds of thousands from other Commands. One Command, in addition to supplying what they could, told us it had just sold 200,000 to a wealthy manufacturer in a West Riding town and, though we saw visions of being mixed up in a financial transaction of having to buy at a high price, surprisingly enough we got this lot also. On Saturday, the 22nd March, the situation became sufficiently serious for a small Operational Headquarters to be set up at Northern Command Headquarters and this had a Sapper Officer on duty or at call the whole time.

The principal step taken that Saturday morning was to ensure that all the Command Store Depots were kept open permanently. This caused quite a flutter on the telephone lines because messages had to be got through by mid-day when these depots, being almost entirely staffed by civilians, packed up for the weekend. However, everyone was contacted by ten minutes to twelve and throughout the operations no call was made on these depots, day or night, without it being immediately complied with.

The next step taken was that afternoon, when the Officer Commanding No. 1. Bomb Disposal Coy. was brought in to York and made O.C. Boats for rescue work. He set up his Headquarters in the Cavalry Barracks and a fleet was gradually assembled under him consisting of folding boats, assault boats, propulsion units and Dukws, the total amounting to about fifty craft altogether. He distributed these to the flooded areas in York, Selby and Barlby. Crews were found mainly from the S.M.E., chiefly from Y.O. classes. The O.C. Boats was in wireless touch with various detachments who

were working in co-operation with the local police. It is, perhaps, difficult to imagine that what in normal times were busy streets had been converted into lakes. It was an exaggeration of the B.B.C. to state that York looked like Lake Windermere, but on the other hand this was true of Selby and Barlby. One feature of this flood rescue work was the extraordinary strong currents that were running, too strong for ordinary rowing, and "power" units were in great demand. Flood rescue work ran on for six days, after which the crisis was over.

O.C. Boats had other things thrown at him to do besides controlling rescue work. Directly after arrival in York he was called upon to advise on measures to protect the City Waterworks. The Ouse was rising very rapidly and there was a likelihood of it flowing into the filter beds. O.C. Boats worked out the necessary scheme of protection, which was executed by a mixed team of soldiers and civilians. The work was completed just in time and no harm was done to the filters; however, an uncomfortable week was spent by many as the Municipality, taking no risks, ordered all water to be boiled and baths were not allowed as all receptacles had to be filled in case water had to be cut off. Meanwhile, to safeguard the barracks and both military and civilian hospitals, two water purification trailers were brought into York from Catterick Store Depot that same Sunday afternoon.

Cavendish Bridge

One of the earliest calls for help was from the Ministry of Transport who asked us to put a temporary bridge over the River Trent, on the main Derby–Leicester road. Cavendish Bridge, scheduled as an ancient monument and consisting of a humped back arch bridge of three main spans, had had a pier washed away (see Photograph 1). The R.E., O.C.T.U. took this on and restored it with a 150 ft. Class 70 Bailey. It is not proposed to tell the story here as it is understood that a special article is being written on this, but it is mentioned to show one of the many calls on R.E. resources.

Selby

The River Ouse which was the cause of the flooding, already mentioned, in York and Selby burst its banks in several places between these two towns. The effect of this was, first a new river, some 200 yds. wide and about 8 ft. deep, formed itself, running parallel to the Ouse for some miles due south; just north of Selby where the Ouse takes a right-angled bend to the east, the new river cut across country and rejoined the main river some five miles further down. The damage done was enormous, the village of Barlby was practically under water and the town of Selby heavily flooded (see Photograph 2), doing great harm to factories producing artificial cattle food; in addition, roads were cut and, worst of all the main London to Edinburgh L.N.E.R. line was so severely damaged that all traffic had to be diverted.

To deal with this situation the S.M.E., in addition to their other calls, took on the job and put it under the Chief Instructor of the Bridging School. The latter produced his own scheme which was approved by the Chief Engineer of the Ouse Catchment Board. The immediate object was to stop more water entering Selby so as to give a chance to what was there already to drain off. A bold and undoubtedly correct decision was made, not to attempt to block the various breaches, but to build a dam just south of the lowest one with a view to holding up the water pouring in from them into the parallel river which had formed itself. To attempt to seal the breaches at that time with available resources would have been an impossible task; they were as much as 200 ft. wide and water was pouring out of them at an

Photo. 1.—Cavendish Bridge.

Photo. 2.—Floods at Selby.
(Published by kind permission of "The Yorkshire Herald.")

Flood relief Ops in Northern Command

Photo. 3.—Site of dam at Selby. One of the breaches in main river bank of Ouse shown in background.

Photo. 4.—Breach in main flood-bank at Crowland causing flooding of 35,000 acres of agricultural land (shown on right).

Flood relief Ops in Northern Command 1

estimated speed of twelve knots. Furthermore, there was no knowing whether other breaches might occur and this, in fact, did happen. At the site chosen for the dam, just below the lowest breach, there was a suitable area for assembling all the equipment for its contruction (see Photograph 3).

The technical scheme in outline form was as follows :—

Anchorages made from Bailey equipment were sunk at each end, the far one having to be floated across on rafts and placed in the old river bank. The two anchorages were joined together with Bailey suspension cable and intermediate Bailey cubes were sunk and filled with stone and sand-bags along the line of the cables. To this framework of anchorages, piers and cable, a network of Sommerfeld track was fixed ; on this network sand-bag filling was to be added and a bank, some 9 ft. high, produced. Work was carried out by Y.O. classes under instruction and two pioneer companies continued at high pressure over six days. Every effort was made to get the greater part of it done by the 6th April, when spring tides were expected which would have made working conditions more difficult. Fortunately, in this area, nature was kind and the river level slowly fell allowing the original breaches in the river banks to be reached.

Crowland

The job which in some ways was the most interesting and gave the most trouble was the Crowland breach (see Sketch on page 245), which lay at the extremity of the Command in the southern corner of Lincolnshire.

To understand the problem of this breach it is necessary to describe the general system of handling water in the Lincolnshire Fens. Each river or canal is expected to flood occasionally and an area known as a " Wash " and consisting of purely pasture land is set aside for this purpose. The confines of each " Wash " is surrounded by a large flood bank to prevent this flood water from drowning good agricultural ground ; the Crowland bank bordered the " Wash " from the River Welland, about half a mile away.

The flooding of the Welland breached this bank to the extent of 240 ft. and 35,000 acres of rich agricultural land was put under water (see Photograph 4). The Catchment Board Engineers attempted to seal the gap by constructing a stone and sand-bag embankment, all materials being taken from Crowland Village along the one and a quarter miles of floodbank to the breach. They obtained military assistance in the form of a party of Cadets from the O.C.T.U. who laid a light railway along the bank and later helped in constructing the new embankment. Great credit is due to these lads, many of whom worked themselves to a standstill. It soon became apparent, however, that this scheme was not the answer and a request was made to Command Headquarters for assistance in the form of an Operational Headquarters and " Neptunes " which had been used in East Anglia. An S.M.E. party was immediately sent down, also a number of L.V.T.s* Further, Chief Engineer, Eastern Command, being contacted telephonically, loaned two officers (one of these actually went to the Selby gap) who had had experience of flood work the previous week.

There was considerable difficulty in getting the L.V.T.s to the gap because of the approaches. Straightforward swimming was interfered with by various underwater obstacles including a line of trees. There were also dykes and banks which, in their slimy state became most effective anti-tank obstacles where the water was shallow enough for the L.V.T.s to get along on the ground. There proved to be only one line of approach and along this the

*L.V.T.—full title " Landing Vehicle Tracked " (an amphibian, approx. 26 ft. × 11 ft. × 8 ft.).

L.V.T.s were brought on to the bank of the New River lying between it and the main breach. They sealed the gap between the newly constructed stone and sand-bag embankments (A, B and C, D on sketch). The spaces in the L.V.T. barrier were well plugged with sand-bags covered with tarpaulins. The military, having completed this work successfully, were withdrawn on the 29th March and the Catchment Board Engineer proceeded to build up a stone-cum-sand-bag wall in front of the barrier.

During the next week, however, the waters rose again and came right up to the top of the L.V.T.s. The pressure became so great that a breach was caused in the bank of the New River under the L.V.T.s and five of these were swept away. Military assistance was again asked for on the 11th of April and this was provided by a party from the No. 1 Bomb Disposal Coy., a boat detachment from the S.M.E. and a control staff from the R.E., O.C.T.U.

The scheme for dealing with this new critical situation was as follows. Whereas the original breach in the floodbank had been sealed by the barrier A B D C a new barrier E F H G was to be built round the second breach. A complication was, however, the 20 ft. wide New River running parallel and just outside the first barrier.

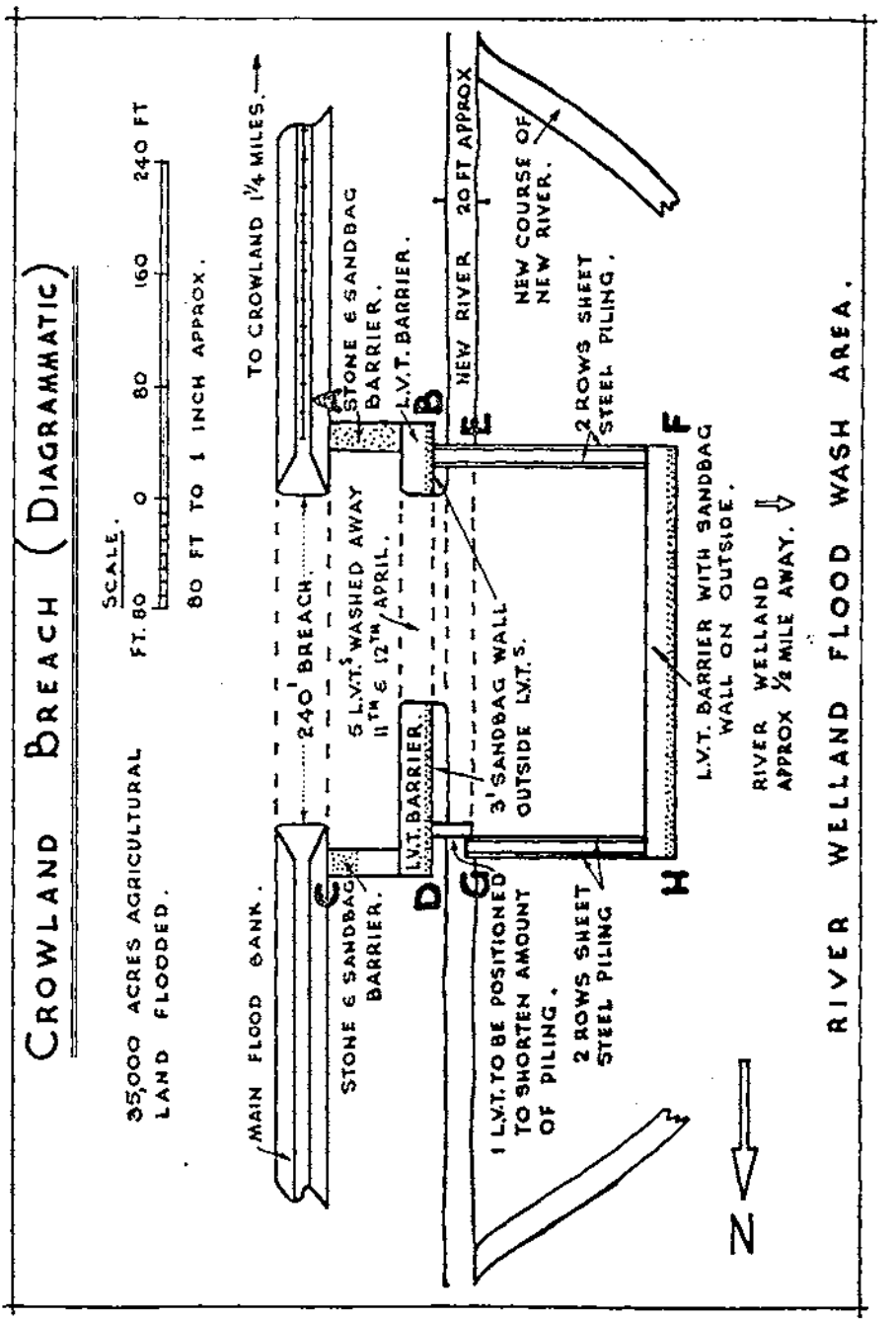
It was necessary to divert the New River by cutting out a fresh bed and building out a sheet steel piled barrier across the old river bed from E to F and G to H. From F to H a fresh L.V.T. barrier was constructed. This scheme was successfully completed on 20th April, 1947.

General Comments

This is not an official paper, so it is not proposed to end it with a statement of lessons learnt but a few general comments are worth recording. In an operation of this nature, in which a military headquarters is set up, the value of "E" being in the very closest touch with the General Staff is of prime importance and this was arranged from the start. Apart from ensuring that G.S. orders took into full account the R.E. aspect, it also meant that the large demands for transport for R.E. Stores were promptly and adequately ordered. Tribute is paid to the R.A.S.C. who carried many large and very awkward loads to difficult sites by day and night throughout the emergency.

Next, the old story of having a good stores organization re-emphasized itself again and again. In Operation "Noah's Ark," just as in war, the forward provision of stores is one of the principal ways in which a Chief Engineer can effect operations. One of the first things done was to think out every conceivable type of store that might be required and ensure that such things as generators, pumps and other mechanical plant in R.E. Store Depots were tee-ed up ready for use if required. It should be mentioned that not only within the Command but also for stores from outside, the Engineer Stores organization functioned excellently. In connexion with stores it is very necessary to have an Engineer trained officer as well as a purely Stores trained officer handling demands as a decision frequently had to be made as to what substitute should be sent.

Turning now to some of the difficulties. The first was lack of Engineer man-power. Not only was there a constant call for engineer assistance for specific jobs, but engineer officers were in great demand for reconnaissance purposes and for work which was not strictly speaking of a R.E. nature. Officers of the right type were not numerically available ; the Works Services are, today, largely civilian and the vast majority of such military officers as there were, were elderly men, untrained in Field Engineering and who could not be expected to adapt themselves to the varying and rapid problems that


CROWLAND BREACH (DIAGRAMMATIC)
35,000 ACRES AGRICULTURAL LAND FLOODED.
SCALE.
FT. 80 0 80 160 240 FT
80 FT TO 1 INCH APPROX.
TO CROWLAND 1¼ MILES.
MAIN FLOOD BANK.
240' BREACH.
STONE & SANDBAG BARRIER.
5 L.V.T.'S WASHED AWAY 11TH & 12TH APRIL.
L.V.T. BARRIER.
STONE & SANDBAG BARRIER.
L.V.T. BARRIER.
3' SANDBAG WALL OUTSIDE L.V.T.S.
1 L.V.T. TO BE POSITIONED TO SHORTEN AMOUNT OF PILING.
2 ROWS SHEET STEEL PILING
2 ROWS SHEET STEEL PILING.
L.V.T. BARRIER WITH SANDBAG WALL ON OUTSIDE.
NEW RIVER 20 FT APPROX
NEW COURSE OF NEW RIVER.
RIVER WELLAND APPROX ½ MILE AWAY.
N
RIVER WELLAND FLOOD WASH AREA.
A
B
C
D
E
F
G
H

had to be faced. In the Chief Engineer's office there was only one regimental officer of the "Field type" and he was kept more than flat out. There were no self-contained R.E. units available except the Bomb Disposal Company who only had a few British Ranks, the others being German Prisoners of War. Had not Northern Command been fortunate in having the S.M.E. and O.C.T.U. in it, many calls for assistance could not have been met.

Before leaving this shortage of man-power aspect one must not overlook the fact that through all this time the hum-drum business of State had to go on. On return to one's office in the evening one found that War Office were waiting for recommendations for new Territorial Army Officers, that there was a Ministerial inquiry over a dismissed employee and, worse than all, some one, some time, had exceeded their contract limits ! !

The second difficulty was lack of an Intelligence system ; one could never tell what demand would come in next and from where. A few of the jobs that were taken on have been mentioned but the list is by no means exhaustive. The shortage of officers made it quite impossible to set up an Intelligence organization with officers out reconnoitring over a large part of England.

There were a number of Administrative difficulties. With the best will in the world it was not possible for Command or District Headquarters to lay on an efficient Administrative set-up in some out-of-the-way place, probably cut off, at the same time as the troops arrived to cope with the emergency. Detachments from schools, etc., are by no means so self-contained as a complete unit, so in a numbr of cases in the early days, some had a particularly uncomfortable time. This was all the more unfortunate as their work, in addition to being hard, was very wet and good hot meals and ample drying arrangements for men and clothes were very necessary. If any unit or detachment is sent out on this kind of work in future, they would be well advised to look very carefully after their own wants and not count too much on what others will do for them.

There was also the problem of working with various civilian authorities ; to what extent did one come in and to what extent could one take charge? Generally, one was called in after the emergency happened and in some cases was given the clear cut task of the immediate restoration of a situation already out of hand. These cases were, perhaps, the simplest to deal with but there were others in which the civil authorities remained in charge throughout, but wanted military assistance for certain aspects only, and in some of these, complications ensued.

Even a fairly straight-forward job like putting a Bailey span across Cavendish Bridge was held up to some extent as this was an ancient monument and the Ministry of Transport were definitely particular as to how much of the original structure should be pulled down and time was occupied in separately marking the various stones that were removed from the piers and arch rings. In the case of the dam at Selby things went well as the R.E. officer produced his plan which was given general approval by the Chief Irrigation Engineer ; the only change was one of policy when the drop in flood level enabled the breaches to be got at. The Crowland gap operations were directed throughout by the Chief Engineer of the Catchment Board. Relations were harmonious, but there were complications, particularly when other civil authorities butted in.

The best course in this somewhat peculiar aspect of "aid to civil power" seems to be to try and ascertain what the whole problem involves and come to a clear cut arrangement as to what the military part of the job comprises. The complication is when one has no confidence that the overall civil plan is an efficient one.

Conclusion

It is thought, perhaps, that this article has made the problems sound over simple as the various tasks are the ordinary Sapper's stock-in-trade. All of us have handled boats, built bridges, light railways and roads. What, perhaps, has not been emphasized enough is the very formidable nature of the enemy, the floods themselves. Until one has actually seen them it is hard to realize the magnitude of the waters. The writer has seen what, up to then, he had imagined to be a heavily flooded area, the Ganges-Brahmapootra estuary, seen from the air, in a trip to Assam in the heavy monsoon of 1942. This was nothing to the Selby floods and those in Lincolnshire were worse. There was a sad and dismal stretch of water extending as far as the eye could see with only the tops of haystacks, buildings and motor buses and lorries appearing. Writers in the Old Testament who, in the Psalms and elsewhere, asked to be delivered from floods knew what they were talking about.

These floods were a national disaster and most people seemed quite dazed by events. For some reason or another, perhaps because everyone is so accustomed to being ordered about, there did not seem to be very much self-help about. The police, generally, were first class, but the same cannot be said of other public bodies and the number of rubbernecks who seemed to have nothing else to do but watch relief operations (without lending a hand) was quite remarkable. To one who saw a very wide variety of tasks, the most cheering factor of a truly damp situation was the remarkable energy, and above all, cheerfulness of the Corps as a whole, who found the work " right up their street."

WATER SUPPLY FOR A BRIGADE ON PACK BASIS IN A DRY ZONE

By Major J. H. Clark, M.C., R.E.

AT the beginning of December, 1944, 32 Ind. Inf. Brigade Group crossed the Chindwin unopposed, and marched for a week up the bed of the Pondaung Chaung, on a pack basis, to the village of Chinyaung, where they had a skirmish with the Japs and did some extensive patrolling. Up till then there had been plenty of running water for mules and men. Chlorinating was done in packals by units themselves, as they were widely dispersed, and no central water-point was possible.

The Brigade Group had till then consisted of four Battalions with all the usual other arms attached, including a Field Ambulance with Surgical team, a Battery of Mountain Artillery, two Mule Companies and two weak Platoons of a Field Company. The strength at the crossing of the Chindwin had been 5,065 men and 1,456 animals. Incidentally, they crossed the Chindwin on improvised rafts and in " Ranger " boats with thirty tons of stores in four days—the only casualty being one mule drowned.

At Chinyaung one battalion left the Brigade on a special job and the strength of the Brigade fell to about 4,000 men and 1,300 animals, and they were supplied every third day by air. Here, orders were received that owing to the speed at which the Japs were pulling out of the mountainous jungle into the plains of Burma, 32 Brigade would change its axis of advance from an easterly direction to a southerly one, and march S.S.E. on to Budalin and Monywa, where the Chindwin runs into the plains.

This entailed marching through a very dry zone of jungle-covered mountains, where, except for the occasional spring, there was no running water at all. Reliance had to be put on village wells, and digging for water in the dry nullahs.

The Engineer detachment had been allotted twenty-six mules. The two weak platoons and a skeleton Company H.Q. formed themselves into one very strong platoon, and carried normal stores for one platoon only and the following Water Supply Stores :—

1,350 gal. " S " Tanks	..	3
L. and F. Pumps Mk. V.	..	3
Delivery hose, lengths	..	6
Suction hose, lengths	..	6
Strainers	..	3

(No mule troughs were carried. The mule companies dug long trenches in the sandy ground and put some dozen mule-tarpaulins and ground sheets inside the trenches, making perfect temporary mule-troughs.)

The whole Brigade Group moved together, except for the Pursuit Party and the Advance Guard, which moved ahead separately, the Pursuit Party being a day ahead of the Advance Guard, which was a few hours ahead of the main body. They moved according to a three-day cycle—long marches for the first and second days, with the minimum of water (two gallons per head per day) being drunk by the mules, and taking no air-drops, and then the third day a short march of eight or ten miles, when an air-drop was arranged, collected and issued, and the mules watered fully.

Watering of mules took a very long time because the flow of water in the wells and water-holes was so small, and after a long day's march watering mules would often continue until late at night, and then have to start again in the early hours of the morning before the next day's march. Sappers had a hard job. After every day's march, apart from digging their own defences, erecting their perimeter obstacles, and making their own bivouacs, they also had to erect, run and dismantle the water-point daily in a new place under new conditions. After a march, water was always wanted immediately, and the Sappers marched straight to the site and began work without any rest, whilst a battle royal raged roundabout as the Regimental Police picketing the point drove off hordes of thirsty men armed with every kind of water-vessel, from a packal to a milk tin. The mules were even harder to control, as one driver was responsible for three mules, and they just carried him away or trampled him under foot, and naturally took no notice of enraged Risaldars.

Discipline at the water-points soon tightened up considerably, as the Sapper officers found they were being driven crazy. Water was only allowed to be drawn in packals, and in no other container of any description (small containers wasted time and water in being filled). Any man going to the water-point had to put his packal on the ground in a straight line in a queue, sit on it absolutely still and not say a word or make a movement until his turn came. Very often the water for mules and men all had to come out of the same water-hole, so that both water-points had to be near together, which didn't improve matters.

Two Sapper subalterns were with the strong Sapper platoon, which was half Sikh, half Mahratta. One subaltern went ahead with the Pursuit Party and found the water for the Brigade and made any arrangements necessary with the locals, if any. The other subaltern went with the Advance Guard and took with him a small party, one tank and one pump and hose ; so that when the main body arrived, a certain amount of water was always im-

mediately available. The other two tanks and pumps were carried by the remainder of the Sapper platoon towards the front of the main body. This system always worked very well, except on one occasion, on Xmas Eve, when the Advance Guard lost its way and arrived after the main body, who found nothing but a stagnant pool waiting for them.

Needless to say the tanks and pumps rapidly wore out and were continually being repaired. The tanks were always either in use or packed up on mules, so the " mochi " soon got expert at repairing them when they were full of water, and later on it became almost continuous work for him. Continuous loading and unloading on mules was very bad for the tanks, and they had to be covered with hessian to prevent them being torn by thorns and branches on the march. The Mark V. pumps were too light for the rough work to which they were subjected. One soon broke down irreparably, and was used for spares for the others. Replacements were dropped eventually, towards the end of the march, when the situation was getting desperate, but till then food had first priority, because the Brigade was always on short rations due to lack of planes, and the difficulty of collecting a complete drop in the jungle when the dropping was done by inexpert aircrews.

A lot of experience was gained at digging water-holes in dry nullahs. Bamboo wicker work type baskets were made on the spot and covered with palm leaves or banana leaves, to keep out the sand and let in the water. These were dug into the sand and water pumped out of them as it ran in from underground. More water flowed in as the hole was made bigger and deeper.

All chlorination was done in the tanks. The Medical Hygiene Corporal tested the water and put in the bleaching powder, and was responsible that it stood for half an hour before drawing. Sedimentation could never be done, due to lack of time and equipment, but it was seldom really essential.

After entering the plains and capturing Budalin, vehicles arrived down the Chindwin and water-carts and petrol-driven pumps came into their own again. The Brigade Group had marched 230 miles on a pack basis from Imphal to Budalin, and continued after that, without a 'rest, on a M.T. basis to capture Monywa and force a crossing of the Irrawaddy.

ROAD RESEARCH IN NORTH AMERICA

THE Department of Scientific and Industrial Research has just issued an interesting pamphlet (published by H.M. Stationery Office, price 1s. 6d.), entitled *Impressions of Roads and Road Research in North America.*

This pamphlet has been prepared as a result of a visit by British Scientists to the U.S.A. and Canada and deals with a number of subjects, including Road Safety, Highway Economics, Materials and Methods of Construction and the Training of Highway Engineers.

Major M. M. Ilott, R.E., also recently visited the Alaska Highway and has written a very full and interesting report. It is hoped to be able to publish some extracts from this report in a future *R.E. Journal.*

AN ASPECT OF SOIL STABILIZATION WITH BITUMINOUS EMULSION

By Major E. Logan, B.E., Australian Staff Corps,
and Major A. E. Ross, B.E., Australian Staff Corps.

THERE are many aspects of soil stabilization still to be investigated before the main problems of this relatively new branch of soil engineering may be solved with a reasonable degree of ease and accuracy. However, during recent years several road projects involving the stabilization of soils with bituminous emulsion have been carried out in Sydney N.S.W. with very satisfactory results. For these works, the approximate amount of emulsion required was determined by the "Colour Test" (see below).

Whilst performing tests preparatory to writing a thesis for the University of Sydney the authors had occasion to compare the colour test results with those of various other laboratory tests with the object of determining the efficiency of the colour test. It is with the hope that the results of this comparison may prove of interest that this paper is presented. As the range of tests was extremely limited, the comparison of results should be treated as an indication of a possible relationship only.

Definition of Stabilization

The term "soil stabilization" as used by the authors in connexion with the admixture of bituminous emulsions is that defined by C. L. McKesson (Director of Engineering and Research, American Bitumuls Co.) as the change in soil characteristics in which the capillarity of the soil and its affinity for water is reduced to a point which will ensure a required bearing strength in the soil under actual conditions of exposure in the subgrade.

Nature of Soil: Test Results

The soil used in the tests was a yellow clay type known to be very unstable when wet and had been formed by the weathering of Wianamatta shale. The following tests and their results were used to identify the soil as an A6 type (U.S. Public Roads Administration system):—

Gravel	..	0 per cent
Coarse sand	..	7 per cent
Fine sand	..	28 per cent
Silt	..	20 per cent
Clay	..	20 per cent
Colloids	..	25 per cent
Liquid limit	..	52 per cent
Plastic limit	..	18 per cent
Plasticity index	..	34
Maximum dry density	..	94 lb./cu. ft.
Shrinkage limit	..	11 per cent
Field moisture equivalent	..	17 per cent

The following additional test results give a further description of the untreated soil:—

Optimum moisture content	..	29 per cent
Absolute specific gravity	..	2·7
Shrinkage ratio	..	2·6

Volumetric change	..	52 per cent
Lineal shrinkage	..	13 per cent
Organic matter	..	1·6 per cent.

Chemical composition of fraction of equivalent diameter between 0·001 mm. 0·002 mm. :—

Loss on ignition	..	12 per cent
Silica ($Si O_2$)	..	40 per cent
Iron ($Fe_2 O_3$)	..	11 per cent
Aluminium ($Al_2 O_3$)	..	35 per cent
Titanium ($Ti O_2$)	..	2 per cent
Phosphate ($P_2 O_5$)	..	½ per cent
Magnesium	..	Trace

Nature and Functions of Bituminous Emulsion

The emulsion used was a special product called " Bitumuls." Basically its composition is :—

Bitumen	..	55 per cent
Agent	..	1–2 per cent
Water	..	43–44 per cent

This is a low penetration slow-breaking bituminous emulsion, processed to give the lowest practical pH value, whose agent is free from " soapy " materials and has a minimum of protective colloidal gel.

Although this bituminous emulsion has some binding value, its primary function is not to produce cohesion in the soil mixture but to protect the hydraulic cohesion which exists due to the presence of moisture films surrounding the soil particles. The action of the bitumen, which is thought to coat small aggregations of soil particles, and under certain conditions may cover or partly cover individual soil particles, is to reduce the amount of capillary water that may enter the mix and to increase the resistance of the active soil particles to the harmful effects of the moisture that does enter.

Colour Test Procedure and Results

For details of the colour test, the authors are indebted to W. B. Carr Constructions Ltd., of Sydney. The directions given are as follows :—

(*a*) Select the sample of soil so that it is as representative of the material on the job as it is possible to obtain.

(*b*) Dry the sample thoroughly at a temperature of less than 150°F., and then pulverize it as well as possible. Rub the soil through a No. 10 sieve until only solid material, having very little dust adhering to the surface, is retained. Make a note of the percentage of material passing the sieve. Reject all material retained by the sieve.

(*c*) Weigh out from about 1 to 2 kg. of the dry pulverized soil and place it in a milk can. Add water to the soil in sufficient quantity to make a stiff paste. Let the dampened sample stand for about one hour to soften and disintegrate any groups or lumps of soil particles.

(*d*) Add a percentage (on basis of weight of emulsion to dry weight of soil sample) of stabilizer to the sample which is believed small enough to be below the optimum point. After practice this can usually be judged quite accurately by a first examination of the soil. If the soil contains considerable sand the optimum point will probably be within a range of from 3 per cent to 7 per cent based on the dry weight of the soil. An extremely fine clay or adobe soil will usually have an optimum point of about 10 per cent to 18 per cent. If it is

judged that it will not fall into either of these groups, use a range starting at about 5 per cent and ending about 13 per cent.

(*e*) Mix the soil and emulsion thoroughly with a spoon or spatula until it is uniformly coloured.

(*f*) Remove a small dab of the mixture weighing approximately 3 to 5 gm. and trowel it in a thin layer on a piece of blotting paper.

(*g*) Now again add stabilizer to the original mixture in an amount sufficient to increase the emulsion content by weight of the dry soil by 1 per cent. Again stir the mixture thoroughly.

(*h*) Remove another small dab of the mixture and place as before alongside the first one on a piece of blotting paper.

(*i*) Repeat this operation until the total percentage of stabilizer is believed to be well above the optimum point.

(*j*) Now dry the small series of pats which have been placed on the blotter until they lose no more weight at a temperature of 140°F. If no oven is handy, and the sun is shining brightly and the weather is warm, place the pats in direct sunlight and allow them several hours of drying. Be sure that they are dried thoroughly.

(*k*) Break up 1 gm. from each of the dried pats and place each in a 1-in. diameter test tube. Fill the test tube about half full with distilled water.

(*l*) Be sure that all test tubes are marked with the percentage of stabilizer based on the weight of the dried soil. Shake all test tubes together vigorously for about 1 to 2 minutes and immediately hold them to the light so that the colour of the suspension can be readily seen. Examine the colour of the suspension in the various tubes and try to determine a point at which the suspension lightened definitely. The percentage of emulsion which gives the first definite lightening in the colour of the suspension is the percentage required to stabilize the soil. If the suspension in all tubes remain about the same colour, shake the tubes together again for another minute to two minutes. Repeat the examination and if possible, select the lowest percentage of stabilizer which gives a light coloured suspension. If all samples remain light, continue as follows :—

(*m*) With a glass stirring rod of about $\frac{1}{4}$ in. diameter, stir the soil in the bottom of each test tube to as nearly as possible the same degree. Stirring should be continued for approximately one minute in each tube. Repeat the examination as before. If it is possible to select a definite line of demarcation do so and note the lowest percentage of stabilizer which gives a light coloured suspension. If no noticeable difference between the samples can be noticed, continue as follows :—

(*n*) Heat the suspension in each test tube to the boiling point and allow all tubes to cool. Shake all the tubes together as before for about one or two minutes and again examine. In almost all cases where no definite difference was noted in the two previous methods a difference will be noted after the boiling.

Note : The amount of stabilizer should not be less than 5 per cent by weight of the dry weight of the soil. If the test shows a figure below this, add further clay bearing materials to adjust the clay content.

Using this test it was found that the suspension first lightened definitely with 7 per cent of emulsion and that the water in which the coated soil particles and aggregations were suspended was first practically clear with 13 per cent emulsion.

Comparison With McKesson's Formula

An empirical formula developed by McKesson and shown below gives an emulsion requirement of 12·8 per cent. The formula is :—

$S = K(0{\cdot}05a + 0{\cdot}1b + 0{\cdot}35c)$, where :—

S = percentage of emulsion required ;

K = a constant for each particular soil. It is usually equal to 1, which value was used ;

a = percentage of soil passing the No. 200 Tyler sieve and larger than 0·005 mm. ;

b = percentage of soil smaller than 0·005 mm. and larger than 0·001 mm. ;

c = percentage of soil smaller than 0·001 mm.

One of the major difficulties in this formula is to fix the value of the constants since, especially for the material passing the 200 sieve, the texture and the chemical and electrical properties may vary considerably in different soils.

Properties of Treated and Untreated Soil

Table 1 (page 255) gives a comparison, in respect to certain tests, of the properties of both the treated and the untreated soil. The clay used is typical of the worst types of sub-grades encountered. It absorbs large quantities of water with a correspondingly large swell. With a reduction in moisture content of only 20 per cent to the shrinkage limit of 11 per cent (i.e. from 31 per cent to 11 per cent) the volumetric change is 52 per cent. These figures show that the soil would be almost useless as a sub-grade without special treatment. However, when the soil is mixed with bituminous emulsion there is a considerable improvement. Within what may be considered normally as an economical range (i.e. up to 13 per cent emulsion) the improvement is proportional to the quantity of emulsion. The swell is reduced by about 40 per cent, the absorption by about 55 per cent whilst the unconfined compressive strength is increased by about 80 per cent.

One of the main points of consideration is the efficiency of the colour test. In the U.S.A. it has been used only to give an approximate value of the percentage of emulsion required and wherever possible extensive laboratory tests are made to get a more exact determination. On the other hand it has been shown in Sydney that the quantity of emulsion determined by the colour test is sufficient to stabilize, in a satisfactory manner, a sub-grade for use in low-cost roads. The author's results suggest that the quantity of emulsion determined by the colour test (i.e. 7 per cent) gives a relatively small improvement in stability, i.e.

Reduction in swell ..	20 per cent	Improvement of 7 per cent emulsion over no emulsion
Increase in unconfined compressive strength	20 per cent	
Reduction in absorption ..	15 per cent	

and it seems rather surprising that such small improvements should give an apparently sufficient degree of stabilization although it is realized that the compression and absorption tests probably imposed harder standards than would be met under usual conditions.

It will have been noted that for this particular soil, the water in which the coated soil particles and aggregations were suspended was practically clear with 13 per cent emulsion. The real significance of this and whether or not other soils give similar results is open to conjecture. There is the suggestion, however, that the colour test may be used to give two different percentages of emulsion, one to be used for ordinary work and the other for that demanding

higher standards. In respect to the higher standard, the improvement gained by increasing the quantity of emulsion from 7 per cent to 13 per cent is as follows :—

Reduction in swell	.. 20 per cent	Improvement with 13 per cent emulsion over 7 per cent emulsion.
Increase in unconfined compressive strength	.. 48 per cent	
Reduction in absorption	.. 46 per cent	

Conclusion

Despite the obvious practical value of the colour test its efficiency is greatly reduced because it does not give any quantitative indication of the degree of improvement which may be expected. A knowledge of the probable behaviour of materials used is an essential for efficient engineering practice.

The authors have deliberately reduced the size of this paper to a minimum and have presented little more than a synopsis of their investigations. They will be pleased, however, to answer any queries or comments and for those who wish to pursue the subject further, there is attached a brief bibliography.

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TABLE I

Property	Percentage of emulsion			Reference and Remarks
	0	7	13	
Swell (Inches in 24 hours)	0·179	0·140	0·11	Test as described in "Rôle of the Laboratory in the Preliminary Investigation and control of Materials for Low Cost Bituminous Pavements"—T. E. Stanton and F. N. Hveem (Proceedings of the Fourteenth Annual Meeting of the Highway Research Board, U.S.A. December, 1934 Part III).
Wet-Dry Resistance	—	Failed after three cycles		American Society for Testing Materials Standards Volume II, 1944 Designation D559—40 T.
Unconfined Compressive Strength (lb./sq. in.)	290	350	520	Specimens were cylinders about 3·4 in. high and 1·75 in. in diameter
Weight of Water absorbed after 27 hours immersion (per cent of dry weight of mixture)	41	35	19	Broken specimens from the compression test were immersed in water

DISCIPLINE AND LEADERSHIP

(A talk given to Officers, W.Os. and N.C.Os. of No. 3 Training Regt., R.E.)

By Lieut.-Col. G. O. N. Thompson, D.S.O., O.B.E., R.E.

Introduction

THE object of this talk to Officers and N.C.Os. is to bring to your notice some essential things about discipline and leadership which are not yet fully understood.

Now that the late war is over, and the main mass of men who served for the duration of that war have left the army, now that policy regarding the new way of life of the present day soldier has been clarified, the time has come to take stock of our position as officers and N.C.Os. We are all on the same side in these matters, so we must have a common doctrine or there is danger that some of us may pull in one direction, but others in the contrary direction. It is not my intention to cover the whole complicated field in this subject about which many great authorities, (notably Lord Wavell) have written and lectured. I do, however, want to make you free of my own thoughts on the subject, not only because it is essential that you shall know my views, but also because I want to give you food for your own thoughts. Discipline is not a fixed or rigid science. It is an art, and should constantly be evolving, developing and modifying itself to meet new and varying conditions. I can only give you the principles that seem to me to be unchanged and unchangeable, and allow you to work out detailed applications for yourselves.

Evolution and History of Discipline and Leadership

The first we learn of mankind is the story of Adam and Eve. Here there seems to have been no discipline and no leadership, and the result is well known to you all. You may regard this story as a fable or an allegory, but it bears its lesson all the same. Then in early history we hear of the cave man and his family. Here it seems some degree of discipline and leadership had been evolved. The cave man ruled his family by fear with a bludgeon. His wife and elder children acted as his N.C.Os. in support of his authority and a family team was built up, even though the discipline was a code based on fear of the bludgeon. Compare this system to the system applied to our armed forces about a hundred or more years ago. There were possibly unnecessary restrictions of personal liberty of the soldier, who was liable to be flogged or given other brutal punishments. Fear still ruled. Not very different from the discipline of the age of the cave man was it ? Next consider the evolution of discipline in the great religions of the world. I don't want to tread on thin ice here, but in the past certainly, and possibly still now, some religious codes of discipline are based on fear. Freedom of thought and freedom of expression are not even now allowed in all religions. But the thing to note is that the disciplinary and leadership codes we all admire are based on the Christian qualities of love of one's fellow men, on human understanding, on the force of example, and a spirit of unselfishness and self-discipline.

I have touched thus briefly on the history and evolution of leadership and discipline because it is essential that in building our own code in the present day army, we must make it as perfect as we can ; we should be foolish indeed if we did not profit by all that we can learn from the evolution that has already taken place.

Theory of an Ideal Code of Discipline

1. *Methods to be rejected*

I want to say at once—" Reject the bludgeon ! " It is clumsy and ineffective because it is rigid and out of date. It depends on fear. Reject also the " Iron hand in the velvet glove." This is only another form of bludgeon. Reject any form of threatening and anything that depends for its effect solely on fear. Reject also any form of Blitz.

2. *Objects of discipline*

If we are to design an ideal code of discipline, we should be clear what are the objects that we wish to attain. I think that they might be defined something like this.

In Peace, so to order affairs in the army that everything runs smoothly, that all ranks are busy, happy and contented, so that everything conduces to make easy our main task, which is to train men, to fit them for their rôle in war. If in the way we order affairs we also turn soldiers into better citizens that too will be another great gain.

In War, to ensure that the orders given by carefully chosen Commanders will be loyally, unhesitatingly and faithfully carried out in pursuance of the national aims.

3. *Need for elasticity of thought and method*

Consider now the material we have to work on. It is ordinary human nature in all its varieties. The methods that succeed with one man may fail with another ; this system must be infinitely elastic to cope with all varieties of men and with all kinds of circumstances ; it must also be based on a knowledge and understanding of our fellow men, their natures, their strong points and their human failings. Elasticity and thorough understanding of our fellow men must therefore be the basis of any really efficient code of discipline.

Practice of Discipline

Nature of responsibility.—All I have said so far is theory, but does not help much in practice. What, you will say, can this chap tell us to help with our real practical everyday problems ? I think perhaps I can help you there too. The responsibility of a L/Cpl. is the same in nature as that of Lieut-Col. It only differs in degree. In many ways it is much harder to be a good L/Cpl. than a good Lieut.-Col., because as the latter you start with an advantage of rank and seniority. As a Lieut.-Col. you automatically get respect, unless you fail in some way that is noticed by your men and thus lose their respect. As a L/Cpl. you have to start by creating that respect, showing that you are worthy of it, otherwise you are bound to fail. Now I cannot say that I know *all* the qualities that men look for, admire and respect in their N.C.Os., W.Os. and officers, but I will tell you some that beyond all question are necessary.

1. *Efficiency*

How can a man have confidence in you, or your decisions and orders unless he considers you are efficient ? You may fool some of the men, some of the time regarding your efficiency, but you cannot fool all of them all of the time. Therefore, the only safe bet is to be efficient. Beware therefore, of biting off more than you can chew. Punch up and get yourself efficient in any subject before you start trying to put it across to others. Aim to be a real expert on the subjects you have to put across. Don't think the little things don't matter, or are not worth while. Take the examples of teaching good turn-out and good lay-out of kits for inspection. A N.C.O. must excel in this himself if he is to get real results from his men. To the slovenly or slack soldier he should be able to say with pride, " look at me," or " look at my kit." " If I can do it, then so

can you if you put your back into it and try." I need hardly say that an officer's turn-out must always be as near perfect as it lies in his power to make it.

2. *Fairness*

This is a cardinal point. Avoid any word or action that can possibly be construed as unfairness or as showing favour or prejudice. It is impossible to help liking some men more than others, that is human nature, and we all have that difficulty, but we must never *show* a preference or a dislike. The best hint I can give you here is to maintain an absolutely impersonal manner in your dealings with juniors in official matters, and avoid any kind of familiarity with them on duty. You must cultivate not only the *manner* of impersonality, but the impersonal way of *thought* when it comes to reporting on men. Force yourself to see the good as well as the bad in those whom you do not like, and the weaknesses, as well as the strong points in those of your juniors whom you do like. This is perhaps the hardest problem each one of us, N.C.Os., W.Os., and officers has to solve, but if we fail to solve it, then we fail in our rank and our job.

3. *Human understanding—Elasticity of mind*

Some are born with this quality. Others are not so lucky but all can hope to attain sufficient human understanding to deal with a wide range of human characters. There are two dangers here. You must not let too great a quality of human understanding of others' difficulties lead you into the mistake of becoming what the old sweats call "cushy." If you are "cushy" you are a menace to yourself because some day you'll get let down by your chaps. You are also a menace to the whole system of discipline because if you are "cushy" you forfeit a great deal of respect. So, while you must use all your understanding and sympathy in discovering a man's difficulties and in helping him to overcome them, you must never accept any other yardstick than perfection in measuring the achievement of your men. A leader of any rank will never get any higher standard of service from his men than the standard he exacts, so you must never be satisfied with less than the best. You can and should however give praise where praise is due, even if the standard reached is not quite perfect.

4. *Self-discipline—the force of example*

Remember always that when you are placed in a position of responsibility over your fellows you become, whether you like it or not, an example to them of what they should aim to be. If therefore, you do not subject yourself to discipline, including if necessary, punishing yourself suitably when you know you have fallen below standard, your men will not achieve any measure of self-discipline themselves, and your work will therefore be much harder, because you will always have to be chasing them to get results. This quality is a very important one because it is a high contributory factor to the degree of respect in which your men will hold you. Here again, if you wish to extract the best from your men, you can only succeed if you never accept anything less than the best of your own performance. Beware on this point. We all tend to slip a bit if we don't watch it, and we must therefore be on guard and jerk ourselves up now and again to avoid the danger of self-complacency.

5. *Loyalty*

Here is a quality equally important whether it works up or down. It is as important to be loyal to your subordinates when dealing with superiors, as it is to support an unpopular decision of a superior to your subordinates. Here I have another word of warning however. Beware of mistaken loyalty. Never support to your superiors what you *know* to have been wrong. Bring forward

reasons for the error and arguments for lenient treatment, but never try to protect an inferior who is really to blame. Always accept responsibility for error if it is fairly yours, rather than let it fall on a junior, but don't hide ever behind a senior yourself. If you get orders you don't agree with or think unwise, say so respectfully when you receive them and try to get them changed. Once you have accepted them, then whatever your secret feelings may be, you must see them through, loyally to the bitter end, and never by word or deed let others see that you do not wholly agree with them. Usually you will find that the chap who gave the order is a wiser man than you, and if he does not accept your views you will probably find in the end that he was right after all.

6. *Ruthlessness*

This is my own idea, and you will find no mention of it in any modern treatise on discipline. It is in fact generally accepted as being a rather unpleasant and Prussian quality, and so it can be if wrongly directed or unpleasantly exercised. Nevertheless I have made some study of all the more famous leaders under whom I have served, and I have observed in each one of them this quality of ruthlessness. It means that once a right decision has been made or an order given, then that decision or order must be pursued relentlessly to its uttermost conclusion. There must be no weakening or turning back, no reconsideration or modification once a right decision or wise order has been given. *No* obstacle must be allowed to stand in the way. Obstructions, human or material must be swept aside and discarded if necessary

You will hear this quality described as determination or as drive or as a variety of other more pleasant-sounding qualities. But no word except ruthlessness fully describes the quality I am getting at: once you know you are right, *nothing* short of your own death must stop you. This is the only quality among those I have described that contains the element of fear.

We all know that a great leader under any code of discipline must be able to lead. But I maintain that human nature being often a weak and fallible thing, a leader must also be able to drive those who are not willing to follow him. It is useless a leader entering battle unless he brings with him his whole army to support him. So while he leads the willing ones he must also be able to drive the unwilling ones and to do this he requires the quality of ruthlessness.

I will give you an example to illustrate what I mean. I may have a warrant officer whom I like very much; he is a nice chap and very popular in the W.Os'. and Sgts'. Mess. The men may like him too, even if they think he is "cushy." However, he is oldish and getting fat and idle; he is out of date and has therefore ceased to be a good W.O. or even a good example. In battle I will see him at once, tell him I am sorry; I realize all the good work he has done in the past, but I can't keep him now because battle is imminent and human lives may depend upon him. I sack him—however much I like him personally, I must be ruthless. When there is no battle, I will see him, tell him his faults and give him a month to pull himself together, because no battle is imminent. If he does not become efficient again, I take him up to the G.O.C. and have him reduced in rank as inefficient. He must not be allowed to interfere with the progress and efficiency of the unit, however much I may like him personally.

Gentlemen, I have done this more than once in the past, and I will do it again in the future if it has to be done, because I have learnt that to get results one must be prepared to be ruthless. The great leaders can exercise

this quality without bitterness and rancour. Thus although the object of their ruthlessness has to go, he knows he has had a fair deal, and so do all the others in the unit. This ruthlessness can therefore only be exercised in conjunction with fairness or it is dangerous. If it is also tempered with human understanding then even the victim holds his leader in continued respect.

All of you too must be prepared to be ruthless when you have to. Never put up with disloyalty, inefficiency or gross neglect of duty. If there is time give a warning and a chance to correct the fault. If not, or if the time given fails to correct the fault, then act ruthlessly, but with fairness and human understanding.

7. *Punishment*

Some of you may wonder why I have not mentioned this before. Well, punishment is the last resort in any ideal code of discipline and should never be used until other methods have failed. I don't like the word punishment, because it has a vindictive sound and no punishment should ever be awarded in any vindictive spirit or manner. The object of punishment is the same as the object of all other aids to discipline—it is correction of faults that have occurred and avoidance of repetition of the same faults in future. As a leader you are getting near the end of your tether when you have to start punishing men to get results.

I must emphasize at once that only commissioned officers are charged with the responsibility of awarding punishments when they have to be awarded. In no circumstances can anyone not holding a commission award punishment in the British Army. There are many good reasons for this, perhaps the most important one being that it is a principle of law that a man is innocent till he is proved guilty. The non-commissioned rank is usually the witness who can prove guilt. How then can he also function as a judge fairly? Witnesses are not judges in any of our civil courts.

All ranks charged with administering discipline must however, understand about punishment, must know what punishments are permitted under Military Law, and also know the powers of punishment of various authorities. You must all of you also learn, if you do not already know, how to frame a charge in dealing with an offence under the Army Act. You must know the rules regarding arrest, whether close or open, and you must know your special responsibility, in the case of men who have committed offences, of ensuring that they are not provoked into committing further or more serious offences. You must in fact make some study of Military Law which is not the subject of this talk to you. Your seniors and officers will help you over this if you ask them. Briefly my views on punishment are as follows —

(*a*) Never punish at all if you can deal with an offence in some other way, e.g., reasoning with an offender and pointing out his offence.

(*b*) Never award a more severe punishment than you need. Once a C.O. has given a man twenty-eight days detention, he can only in exceptional circumstances avoid sending that man for Court-Martial for his next offence.

(*c*) Don't turn men into military criminals by putting a lot of minor punishments on their conduct sheets. Extra guards and piquets need not always be so entered.

(*d*) Make the punishment fit the crime. Never give C.B. unless a man's offence shows that he has abused his liberty to move abroad as he pleases out of duty hours.

For a dirty rifle, make him show it several extra times in a clean condition. For a slovenly kit or turn-out use similar measures.

(*e*) Never send a man in front of the C.O. unless as Company Commander you have done your bit with him and failed.

(*f*) Never be prejudiced by a man's apparent bad record in a previous unit. He may have been unlucky. On the other hand, after you have found him to be guilty, look at his conduct sheet, and if he has committed the same offence before in his present unit, then beware of letting him off lightly the second time.

8. *Miscellaneous Points*

(*a*) Always remember Officers and N.C.Os. are a team and must work as such. Never let each other down.

(*b*) If serving in a Training Battalion remember that you are dealing with intelligent young recruits who are mostly out to learn, so give them all the rope you legitimately can, particularly in their first few weeks.

(*c*) Always warn a soldier when you are putting him on a charge. Tell him he is in open arrest, and may not leave camp or visit the canteen till his case has been disposed of. If he is being put in close arrest tell him, but make sure you are protected by escort when you do so. Always get the charge sheet written and presented to the C.S.M. at the earliest possible moment, never leave it till a succeeding day.

(*d*) Always tell off an Officer, W.O. or N.C.O. in private if you have to do so at all. Never do it in front of men or you may undermine the authority of one of the team, quite apart from causing resentment against yourself.

(*e*) Don't leave things to the R.P. or C.M.P. to put right. It is *your* job, in barracks or outside, on or off duty to correct faults when you see them.

Summing Up

If you are to get good discipline you must be :—

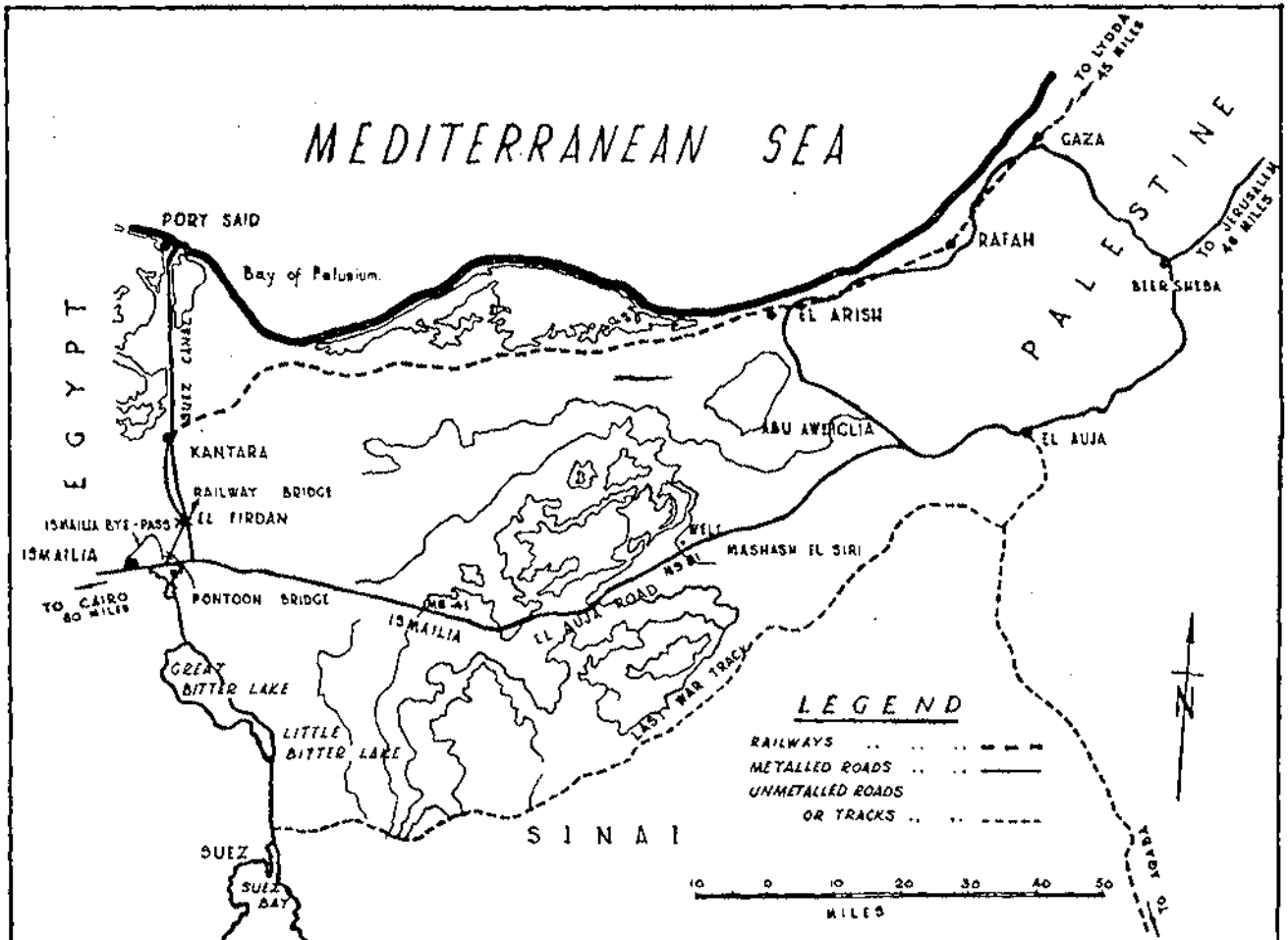
Efficient.
Fair.
Full of human understanding and elastic in mind and thought.
Loyal to superiors and inferiors.
Able to discipline yourself.
Be ruthless when you have to be, *but NEVER threaten.*

You should also be good-tempered, patient, kind, gentle-mannered, long-suffering and many other things, but the things I have told you are the most important, and if you get them right the other things are easy.

You must know the principles and practice of the British code of Military Law. It differs little from civil and criminal law in this country except that it makes certain purely military offences punishable..

If you can master all this you will be so far on the way to being a good leader and instilling good discipline, that all the rest will come easy to you.

ISMAILIA—EL AUJA ROAD



ISMAILIA—EL AUJA ROAD

By Colonel G. K. Cassels, O.B.E.

Foreword

THE writer's connexion with this road, together with its links to El Firdan and Rafa, lasted from September, 1941, to early August, 1943. This article was written from memory, assisted by three general Works Progress Reports, each six months apart, which covered all the work in the C.R.E.'s area, and not this job only.

Location

The main road traversed Sinai from the Palestine road system at El Auja, in the hills east of Rafa, to Egypt proper. The Suez Canal was crossed by a chain ferry at the French hospital, Ismailia, and by a pontoon bridge, built at the end of 1941, about one mile to the north. The length of the main road was about 144 miles from the Palestine border to Ismailia.

In the first half of 1942, a link about seven and a half miles long was built, from a point about two miles east of Ismailia to the newly constructed El Firdan railway bridge over the Suez Canal, which had been decked for road traffic.

El Arish—Rafa Link

In the middle of 1942, airfields were made a few miles west of El Arish, and the traffic to them and to their connected bomb dumps soon made the earth road impassable. A stone road from Abu Aweigila (about 121 miles east from Ismailia) to El Arish was projected, but had to be abandoned, owing to lack of transport. A mix-in-place road, about thirty miles long, was made to El Arish in the latter half of 1942, which continued to Rafa, just on the Palestine border, and joined up with the Palestine coast road system. The portion from El Arish to Rafa was made by the C.R.E., Gaza.

Other Communication Lines

The Ismailia—El Auja road was further north than the first German war road, which was only fit for occasional M.T. use, and quite unsuitable for fast moving convoys. The latter road was, in fact, hardly ever used, and the Ismailia—El Auja road remained the only link between Palestine and Egypt, except the single line railway, which crossed the canal by the train ferry at Kantara, and later the swing bridge at El Firdan.

Original Construction

The history of the original construction is not known to the writer, but it is certain that credit for the conception, which proved strategically invaluable, must be given, at least in part, to the Royal Engineers Advisers in Cairo and Jerusalem. The road was 19 ft. 9 in. wide, and originally just under 5 in. thick, and was built by the Shell Co., Egypt, shortly before the war, using their own bitumen from the Suez refineries. The bitumen used was a cut-back, probably F/70, and the mix was made in ordinary paddle mixers of the Millars type, with cold sand as dug on site. The aggregate varied greatly, being fine sand in some places, and having a considerable proportion of fine gravel, and even small clay lumps, in others. The mix had been sealed at least once with sand. No chipping sealing coat was ever applied prior to 1942.

Reasons for Deterioration

On completion, the road was handed over to the Egyptian P.W.D., who had a very weak organization on the ground. The maintenance may have been sufficient for peace traffic, but was quite insufficient for war. Further, the original construction was, probably due to lack of funds, essentially faulty as no haunches and no kerbs were provided. The continual pounding of lorry traffic caused the road to spread with a consequent thinning in the longitudinal wheel ruts. Eventually the edges tended to rise, and a crack formed, first about 2 ft. from the edge and running longitudinally, and later near the centre of the road, where the inside wheel was moving.

R.E. Services Take Over

Up till the end of 1941, R.E. responsibility for the road was confined to the rendering of monthly reports on its condition. In November–December, 1941, the condition of the road became so serious that R.E. services had to take a hand, though Chief Engineer B.T.E. had little staff and plant available to give to it.

Units Employed

The job was given to C.R.E., North Canal Sub-Area, who later became 54 C.R.E. Works. As he had only two D.C.s R.E. to cover all the engineer work from a point three miles south of Ismailia up to and including Port Said, the job was entrusted to an Artisan Works company of S.A. Engineers.

This unit had an establishment of N.C.O.s of European origin, while the remainder of the men were Cape coloured. All the tradesmen, and the M.T. drivers, of whom there were at least 80, were made up of the latter. Even then, the C.R.E. was not able to make the whole company available for the road as a detachment, of at least platoon strength, was throughout employed elsewhere on hospital and other construction. This personnel remained in complete charge of the road for upwards of a year, when a D.C.R.E. establishment was made available, and further a second S.A. Artisan Works company allotted for a short time. Even after the D.C.R.E. was appointed the original company remained at work on the road, and their connexion with it lasted about one and a half years.

Haunching

It was obvious that the immediate need was to prevent further spreading of the carpet, and to prevent the spreading starting in places so far unaffected. The use of concrete was considered, but difficulties of shortage of cement, transport of water and of stone crushing ruled this out. It was eventually decided to provide dry stone berms 3 ft. wide with a haunching stone at least 15 in. deep, supported by other stones outside it tapering to a minimum depth of 6 in. The purpose of this stone berm was not only to prevent spreading but also as a stabilizer to prevent sand movement. The kerb stone projected 2 to 3 in., even though this tended to hold blown sand, in order to act as a shoulder for the premix carpet which it was eventually intended to lay. Some fears were expressed at that time that this raised kerb might cause accidents, but in the event it was proved that it did not. These stone berms were not intended to carry traffic, but unfortunately a great number of drivers, either through carelessness or exhaustion, thought otherwise, and parties had to be continually at work replacing stones. The average cross-section of each berm was just over 2½ sq. ft., and it was originally intended to complete about one third of the length of the road. Even then, the original project presented a very big transportation problem as, assuming

the average density of the stone to have been 130 pounds per cu. ft., the weight to be moved was 74,000 tons. In the event, it was found necessary to do practically the whole road, but in some places which had a hard gravelly foundation, it was found possible to reduce the berm to a width of 1 ft.

Availability of Stone

Extensive air and ground reconnaissance revealed that the western end of the road was practically bare of stone, but from M.S. 41 onwards, the average carry was about eight miles.

A new source of soft white stone, suitable for berms only, was found about two miles east of the canal and well off the road to the south. This stone was greatly inferior to the Fayid stone, so well known to Engineers in the canal area, and had an overburden of 1 to 6 ft. of earth. No machines were available, at that period of the war, to remove this overburden and extraction was started by D.E.L. to establish a rate, and subsequently continued by contract.

Good hard stone outcrops existed at M.S. 41, and the first camps were set up at Ferry Point, the Base, and at M.S. 41. Over this section, which contained some of the worst cracked areas, the stone carry was, therefore, twenty miles.

Kerbing stone was extracted by D.E.L., except near Ferry Point, as contractors could not be found to undertake quarrying work further east.

Transport of Berm Stone

The organization of M.T. is not an R.E. service, but unfortunately Engineers are very often required to do it. The war in the desert was putting a great strain on transport resources and no unit was available. Fifty three-ton Chevrolets were issued in January or February, 1942, but for some months all maintenance and repairs had to be carried out by the Artisan Works Coy. itself, without any outside assistance, in spite of the fact that some of these vehicles were so bad that they were actually towed into the base camp.

A start was made however, and it readily became apparent that the berming work did prevent further spreading and deterioration of the road surface. By dint of much help from Engineer headquarters at B.T.E. the staff began to realize the vital nature of the work, and later an Ordnance (now R.E.M.E.) detachment and a G.P.T. company were provided.

Water Supply

This was in itself a major problem, as no water was at first found between Ferry Point and Abu Aweigila, 121 miles to the east. A thorough examination by water diviners failed to produce any hopeful reports. Some months later a geologist predicted water, about eighty-one miles from Ferry Point, which a 500 ft. tube well produced at the road side. In thus finding water in the desert of Sinai, R.E. services were one up on Moses. This water was full of salts and Andrew's Salts were unnecessary there. This well, however, was not developed till the project had been in train many months, and for long some of the precious three-tonners were carrying 400 gallons of water instead of two and a half tons of stone.

Maintenance

It was originally intended that the Egyptian P.W.D. should carry on, but their staff was inadequate and not particularly well instructed, as the Engineer-in-Charge lived in Cairo. Though the three officers of the Artisan Works Coy. were already fully engaged on berm work, mixers had to be set

up about every twenty-five miles, and patching started. This was in full swing by July, 1942. It entailed cutting out the old mix squarely, painting the edges, filling with stock bitumen-sand mix, and tamping. Traffic did not spoil these patches and it was found that stock several days old was quite as good for this purpose, if not better, than new mix. This work went on continually until the premix was eventually superimposed.

As well as this maintenance work, some of the better sections, on which it was anticipated that premix could be postponed for say twelve months, were sprayed and blinded. Over thirteen miles were treated in this way.

Sand Clearance and Scour Damage

There is almost always a wind in the Sinai Desert and dunes threatened the road in many places. Some were towering hills 25 ft. higher than the road, and some resembled the waves of the sea, when sand blew over the road to a depth of a foot or so, for perhaps a quarter of a mile at a stretch.

Some hundreds of coolies were always at work on sand clearance and after serious windstorms the number went up to nearly two thousand.

A platoon of a New Zealand M.E. company did sterling work and removed some of the most threatening dunes. Sand was, however, a serious enough threat to necessitate the reconnaissance of two diversions of two and a half miles and four miles respectively, which would probably have had to be made if Alamein had not been such a decisive victory.

The users of this road must often have cursed its sudden dips and rises, and its bends. The original Construction Engineers did well in keeping the road as near as possible the same height as the sand. It is certain that if this road had been a level "Autobahn," with cuttings and embankments, "duning" and scour would have been so bad that we should never have kept the road open.

Any engineer setting out roads or railways in dune country in future must give serious thought to the questions of sand movement and sand fixation.

It is hoped that in future wars we shall have earth shifting machinery and thus avoid the necessity of maintaining armies of coolies in a country where every gallon of water and every pound of food and fuel have to be carried many miles by M.T.

Carpeting

(*a*) *Plan.*—The original intention was to undertake forty miles of 2 in. hard stone carpet, ten miles at the west end by the use of stone from the Cairo area, and thirty miles with local stone, either quarried and crushed or gathered from the surrounding hillsides. It eventually became necessary to carpet the whole road and it is understood that this was completed by the end of 1943.

(*b*) *Stone Used.*—The contract at the west end was deviated to cover twelve and a half miles, and with that exception all stone was obtained locally. Far the greater part was quarried and crushed by the main carpeting contractors, the Shell Co. of Egypt, using W.D. machines. In some cases there were deposits of stone not too round in shape, and Sinai contractors, recommended by the Governor of Sinai, who was a British Officer, were obtained to collect and screen this by the road side.

(*c*) *Grouting.*—This latter stone was very hard, and was spread by hand, and grouted with hot bitumen from cans. This resulted in quite a good job, but used twenty per cent more bitumen and required more rolling than the premix. Only the harder stone was used for this grouting process.

(*d*) *Premix.*—The remainder of the carpet was laid in premix, mixed in movable mixers at the roadside. All handling of the mix was done in small

two-wheeled carts, with pneumatic tyres and sheet iron bottoms. Very little of the stone was mechanically dried, and none was heated before mixing.

Some of the stone, which perforce had to be used in the mix, was too soft, and showed signs of crushing under the six-ton and eight-ton rollers available. This fault was corrected by sealing these sections earlier than those for which hard stone was available.

(*e*) *Machinery and Transport Arrangements.*—No conveyor belts, scrapers, or mechanical shovels were available for the quarries, but time taken up in the methodical arrangement of such machines as were available was amply repaid by results.

The stone extracted from the hill-side quarries was stacked above the crusher platform and, in the best arrangement, was handled down till it fell into the hopper of the crusher. No tipper lorries were available, so the normal arrangement of shovelling down into trucks was not found as efficient as was the filling of a stipulated number of baskets. These baskets were carried full in the lorry and could be quickly unloaded, which greatly increased the vehicle turn-round. It was found essential to keep a responsible supervisor at the loading point, with a list of lorry numbers, whose sole duty was to note the number of trips made by each vehicle. The appointment of these supervisors immediately added sixty per cent to the output.

After much consideration crushed stone dumps and mixer points were set up about every 300 yds., which meant a maximum carry of 150 yds. each way for the mix.

Labour

The Sinai Desert, though not flat as its name implies, is practically uninhabited. The only organized labour ever provided for the Engineers, which was certainly as bad as any labour can be, consisted of two battalions of Italian native prisoners from Cyrenaica and Tripolitania. These men were indisciplined and lazy, and their officers had most restricted punishment powers.

There was, unfortunately, nothing to correspond to the Egyptian Labour Corps of World War I, and the labour from the canal area was already lucratively employed. Rates of pay were restricted, and it was sometimes difficult to get P. and L. staffs in Cairo to realize that some considerable bonus was needed to induce labourers to brave the heat, or cold, and dust of the Sinai desert.

Supervision was very difficult to arrange, but the Engineers, as usual, insisted on the value of task work in the face of quite determined opposition from some staff officers. On one occasion one such, on a flying visit, reported the shameful fact that some labour was back in camp by 14.30 hrs., and insisted on an eight hour day. The correspondence ceased, however, when the writer pointed out that he preferred his labour to work for six and a half hours rather than to do nothing at all for eight hours.

Hygiene

The main enemies were the fly in the hot weather and the louse in the cold. Of the resultant diseases, typhus in the winter was the most serious and claimed a number of victims among the labour. From experience gained it may be said that the mimimum facilities which must be provided in such circumstances are as follows —

(*a*) An N.C.O. or Supervisor for each camp, with some disciplinary powers and a few sanitary assistants.

(*b*) Camp Latrines. If caste permits, as in Egypt, portable timber tops are as good as any and can be made more or less flyproof.
(*c*) Some small canteen where ration issues can be supplemented.
(*d*) Disinfestation arrangements not less than fortnightly, both for clothes and bodies.
(*e*) Some organization of labour into platoons of about fifty to facilitate inspection (and also the issue of food and water rations).
(*f*) A daily sick parade and arrangements for evacuation of the sick.

El Firdan Link

This road was about seven and a half miles long and was intended to enable convoys to move up the east bank of the canal to the railway bridge, should the Ismailia pontoon bridge (metal lighters) have been destroyed. This link was surveyed and built by the normal Works Staff of 54 C.R.E. Works, and the work was done by an A.G.E. of 58 years of age. Concrete kerbs were set out first and the road was made of 5 in. thick bitumen-sand mix, 19 ft. 9 in. wide.

The road was somewhat too well engineered, and some scour trouble was experienced, but the whole line appeared intact when viewed by the writer from a B.O.A.C. plane in June, 1945.

Abu Aweigila–El Arish–Rafa Link

This link was about sixty miles long and was built to the same specification as the El Firdan link by the Shell Co., supervised by C.R.E., Gaza and 54 C.R.E., Works.

Kerbs were partially of local stone, which is inferior to concrete both in strength and for setting out purposes. By the time this work was undertaken a D.C.R.E. with one A.G.E. had been appointed, who were made responsible for the Ismailia–El Auja road as well as this link.

This Road had to be built in cold, wet weather and setting up of the mix was slow. A small percentage of this, which was made with damp sand, had to be relaid.

Use of Ismailia–El Auja Road

The value of this road to the C.-in-C., M.E.F., will be obvious to anyone with even a superficial knowledge of the happenings in the desert, in Syria and in Iraq. It is sufficient to say that the road withstood the impact of several large scale convoy movements, both westwards and eastwards besides its regular heavy traffic. During the movement from Paiforce, which helped to halt the enemy at Alamein, the traffic volume went up to over 1,000 vehicles a day for at least a week. This would be a heavy commitment even for a stone road.

This road was surely one of the most cosmopolitan in the world. Britishers, Indians, Australians, New Zealanders, South Africans, Americans, East Africans, Poles and Free French, besides many Egyptian and Palestinian civilians, followed one another in an endless stream. Every kind of vehicle used the road, but fortunately the ten-ton lorry and the transporter were fairly uncommon up to 1943. With the exception of the very heavy vehicles, there was no doubt that the towed field gun, moving fast and swinging a good deal, did the most damage, and every possible effort to limit speed was made. It is understood that the road was intended as one of the main lines of retreat, should the enemy not have been held on the Alamein line, but it was fortunately never put to this purpose, nor were the extensive water supply preparations ever used.

Supervision

There can be no more exacting task for Engineers than actually living on such a desert road, with its extremes of heat and cold, and almost incessant dust, for months on end. Every effort to give them a relief or leave should be made. The travelling cinema vans, latterly provided by the South African Welfare Services, were greatly appreciated both by officers and men.

Lessons

(*a*) Adequate intercommunication is most important and a telephone almost a necessity.

(*b*) For purposes of control of maintenance, a road must be divided into sectors, whose supervisors can report breaches, necessity for diversions etc.

(*c*) As always, Engineers must have adequate M.T. The use of load carrying vehicles for inspection work is wasteful and inefficient.

(*d*) If Engineers must organize their own M.T., then, as far as possible, special staff should be detailed to supervise the loads carried, and the trips done, and nothing else.

(*e*) Special maintenance periods are as necessary for R.E. machinery as they are for M.T., and in calculating the numbers of machines needed this must be allowed for. Supervision of maintenance should be by the best mechanics available.

(*f*) All machinery, including boilers, will never be properly mobile till it moves on pneumatic tyres.

(*g*) Bitumen boilers require maintenance as for any other machinery.

(*h*) The method of indenting for spare parts, and the drill for following up the indents, must be first class.

(*j*) Transporters for the evacuation of badly damaged machinery are essential.

(*k*) A good Quartermaster to control the issues of tools, food, petrol, tentage, etc., from base camp is absolutely essential, and he should be appointed from the beginning of the work.

Conclusion

In conclusion it may be said that an effort was made from first to last to impress on all concerned that the work was of the utmost strategical importance. The continued use of the road by large troop formations helped greatly to prove that this was true. Though this was an unspectacular L. of C. job, great enthusiasm was shown throughout and the fact that this route was kept open, often under great difficulties, reflected great credit on the officers and men, whether British, South African, or Egyptian, who were employed on it.

MEMOIRS

LIEUTENANT-GENERAL SIR EDWIN H. de V. ATKINSON K.C.B., K.B.E., C.M.G., C.I.E.

LIEUT.-GENERAL SIR EDWIN ATKINSON, who died on 1st April, 1947, was one of the outstanding officers of the Corps of his own generation. He was born on 19th February, 1867, and was the son of the late Mr. E. F. T. Atkinson, C.I.E., of the Indian Civil Service. He was educated at Charterhouse and the R.M.A., Woolwich and was gazetted to a commission in the Corps on 16th, September, 1885.

After the usual young officers' courses at Chatham, he went out to India and was lucky enough to see active service in Burma and on the North-West Frontier during his five-years' tour, which was mostly spent in the Public Works Department.

He came home in 1895, on appointment as instructor at the Shop : one of his jobs was to teach geometrical drawing, a subject of which he professed to be ignorant ; it was typical of his thoroughness that he decided to master this science by sitting down and writing a book on it, which was immediately adopted as the text-book for the Shop curriculum. It was during his tenure of this appointment that he married Ethelred Steward, a lady of outstanding charm who played no small part in the successful career of her husband. They celebrated their Golden Wedding about a year before Atkinson's death.

In 1899, Atkinson returned to India for service in the Military Works Department and two years later he was appointed Principal of the Thomason Engineering College at Roorkee, a post which he held until the outbreak of World War I. With characteristic energy, he set about enlarging the scope of the education and bringing it up to date, especially on the mechanical engineering side as he took an early and great interest in motoring which was then in its infancy, at least so far as India was concerned. He was a prominent figure in the social life of Roorkee and excelled at games, being indeed one of the best polo players in that small station. He was also well-known in Simla, where he and his wife generally spent their annual holiday and became well-known figures.

It looked at one time as if he was destined to make his career in civil employ in India, but the outbreak of the War in 1914, gave him the opportunity, which he gladly grasped, of returning to regimental duty and of again seeing active service. He thus cut adrift from civil employment which did not seem to offer any real scope for advancement, and entered upon the final period of his service which was destined to bring him the opportunities for using to the full his outstanding gifts of initiative, foresight, energy and determination.

He was appointed C.R.E. of the 38th Welsh Division in 1915, and he went to France soon thereafter. Although he had spent such a long time away from military duty, the way in which he tackled his job marked him out for early advancement, and within one year he was appointed Chief Engineer of the 1st Corps, with the rank of Brigadier-General. By the beginning of 1918, he was already Chief Engineer of the First Army and had made a reputation for himself as one of the leading engineer officers in France. General Lord Horne, who was his Army Commander, reported on him in the following terms :— "far above the average in ability, judgment and common sense, with

professional knowledge of a high order with a vast store of energy : for him difficulties only exist to be overcome successfully."

When the War was over, it was not surprising that he should have been selected for the difficult post of Chief Engineer in Iraq, where the post-war conditions were none too happy. Whilst his real job was that of Chief Engineer at G.H.Q., he was called upon by the Civil Commissioner to submit proposals for the organization of a Public Works Department and Secretariat for Mesopotamia. The Chief Commissioner, Sir Arnold Wilson, acknowledged in no uncertain terms his gratitude for the work Atkinson had done in his civil capacity.

During the Arab rebellion, he was appointed G.O.C., L. of C. defences from Basra to Samawah, a job which gave plenty of scope for the exercise of that initiative which was one of his leading characteristics. He organized and commanded a force known as "Atcol" and played an important part in the suppression of the rebellion in the area for which he was responsible.

In the interval between the end of World War I and his going to Iraq he was a member of the War Office Committee on Engineer Organization whose president was Lord Rawlinson. The latter was so impressed by Atkinson's ability that, on his appointment as C.-in-C. India, he pressed to have Atkinson transferred from Iraq to India to take up the appointment of Director-General of Military Works. Things had not been going well in the Military Works Services since the end of the war ; it was very short of regular officers, there was a serious post-war mess to be cleared up and the critical and unhelpful attitude of the staff at Army Headquarters had produced a feeling of frustration at the top which permeated the whole service. The arrival of Atkinson at Simla in 1921 was like a breath of fresh air to the harried officers of the service which he had taken over. The C.-in-C., immediately showed his confidence in him by ordering him to report direct to himself on the measures necessary to put the Military Works Services on to a proper footing again. In a surprisingly short space of time Atkinson produced his recommendations which were accepted in full. He changed the title of the Service to "Military Engineer Service." which in itself had a good psychological effect. He increased the establishment of officers considerably above the pre-war level and obtained an appreciable improvement in conditions of pay. His own position, as head of the Corps in India, was enhanced by his being appointed Engineer-in-Chief with direct access to the Commander-in-Chief instead of through one or other of the Principal Staff Officers. In short he became a power in the land, and the prestige of the M.E.S. rose accordingly. Lord Rawlinson reported on him at the time as "the best and broadest minded senior Engineer officer I have come across."

The energy with which he carried out his job as Engineer-in-Chief marked him down for selection as Master-General of Supply in India, a new post which was introduced in 1924 to bring all the purchasing organizations of the Army under one head. This title was changed four years later to that of Master-General of the Ordnance in order to conform with the more logical organization at the War Office. Atkinson thereupon became the first M.G.O. the Indian Army had ever had.

Atkinson retired in April, 1930, a young man for his age and still full of that energy which had been such a feature of his long years of service on the active list. Unfortunately he was unsuccessful in obtaining any permanent employment in civil life though he was amply qualified to go on working and did indeed go to China for a short time to represent an industrial firm. The economic slump of that period undoubtedly made it difficult for a man of his age to find a permanent job, so he settled down to family life in London.

In recognition of his exceptional services before, during and subsequent to World War I he was awarded the C.I.E., in 1913, the C.M.G., in 1917, the C.B., in 1918 and was created a K.B.E., in 1921 and K.C.B., in 1929. He was also made a Grand Officer of the Portuguese Military Order of Aviz, a Commandeur of the Legion d'Honneur and awarded both the French and Belgian Croix-de-Guerre.

I have always ranked Atkinson as one of the outstanding R.E. Officers of his generation. He had tremendous force of character and determination and was possessed of mental powers far above the ordinary. Had he adopted a career in civil life instead of the Army as profession, he might well have become a national character. He had the knack of extracting the best out of those who served him, a characteristic which was ignored by some of his critics in India who assumed that, because he enjoyed life and did not keep his own nose to the grindstone during the later years of his service, he was growing idle. Such critics overlooked the fact that the services over which he presided whilst he was at Army Headquarters were most efficiently directed by him, and that the head of any organization who allows himself to become immersed in detail soon gets into a condition of not being able to see the wood for the trees. Atkinson was no slave driver, but he did extract very willing work from his subordinates, as any R.E. Officer who served under him will freely acknowledge. He could be very stern when occasion demanded it, but he was never unjust.

Apart from his work Atkinson enjoyed life to the full. Very happily married, he brought up a family of three girls and a boy who have all done well. He was a great player of games, loved a game of Bridge or Poker, and was the life and soul of any party at which he was present. We, his friends, deplore the loss to hia generation of a great Sapper and a very fine soldier and gentleman.

J.R.E.C.

Lieutenant-General Sir Edwin H de V Atkinson
KCB KBE CMG CIE

Brigadier-General William Baker Brown CB

BRIGADIER-GENERAL W. BAKER BROWN, C.B.

WILLIAM BAKER BROWN was born on 27th April, 1864, the son of Isaac Baker Brown, F.R.C.S., of Colne Engaine, in Essex, by his second wife. He was educated at Charterhouse and the R.M.A. Woolwich, passing fourth into the " Shop " when he was barely seventeen. Two years later, in February 1883, he was commissioned in the Royal Engineers, winning the prize for Military Topography on leaving Woolwich.

After the usual two years at the S.M.E., he stayed on at Chatham with the 23 Sub-Mining Depot Coy., at St. Mary's Barracks. At the completion of the normal eight-months course he was at once posted as a Temporary Asst. Instructor, at the S.M. School, Gillingham, to balance the large expansion of this branch of the R.E. taking place at that time. After three years on this work Baker Brown applied to go abroad and in January, 1889, sailed for Mauritius, breaking his journey at Cape Town where he stayed for six weeks. During this period he returned to his first love, topography, by carrying out the survey of Wynberg Camp.

At Mauritius, the command of a small company of eighteen British N.C.O.s and forty native sub-miners, carrying with it the paid local rank of Captain awaited him. The company was soon so well trained that when it had to lay the new minefield the time taken was one sixth of that originally estimated. Here some experience in " Works " came his way, as he helped to construct two new forts mounting 9·2 in. guns. He also undertook the salvage of a sub-mining launch, sunk in the harbour during a cyclone.

In June, 1891, two months before attaining his substantive Captaincy he married Francis Kate, the daughter of The Venerable R. T. French, then Archdeacon of Mauritius ; a lady who proved the greatest help to him in his future career. Next year Capt. Baker Brown returned to England to take up the appointment of Asst.-Instructor S.M. School, Portsmouth. From 1894–95 he was left in charge of the School, and the S.M. Coy., owing to the illness and subsequent death of his chief. During this period he prepared the new scheme for D.E.L.s from Southsea Castle to Nettlestone, Isle of Wight, which was later installed and continued in use until 1914. Towards the end of 1895 Dumbleton relieved him as Chief Instructor and O.C. Coy., at Portsmouth, and early in 1896 Baker Brown was appointed Chief Instructor S.M. School, Gillingham, with E. C. Seaman as his assistant for Brennan Torpedo work. As C.I. he was an ex-officio member of the R.E. Committee, which later developed into the R.E. Board, and did valuable work on the Sub-Committees dealing with new sub-mining and coast Defence Searchlight plant. In 1898, he won the Gold Medal of the R.U.S.I. at the unusually early age of 34, for an essay on :—" The Organization of a Military Force for Home Defence," which advocated the formation of the Home Army, including the Militia, into Army Corps Groups, and the organizing of Volunteers to take over Coast Defence.

During the South African War, Baker Brown, with others of the senior Staff of the S.M.E., could not be spared for overseas ; but as work in the Sub-Mining School was reduced he employed his time in re-writing Vols. I–III of the *Manual of Sub-Marine Mining*, completing the last en route to Hong Kong where he was posted, now a Major, to command the Sub-Mining Coy., which consisted of a hundred British personnel and some sixty locally enlisted Chinese. This was a most interesting period in the history of Hong Kong. The Boxer Campaign was dying, and the Colony was preparing to take over a new area of about 400 square miles, on the Kowloon side, almost up to Sum-Chun, afterwards known as the New Territory. This in-

volved additional fortifications, guns, and D.E.L.s at both harbour entrances : a layout of telephone communications, and a revision of the minefield. The new O.C. took his full share in this congenial task, making suggestions for the new layout which, in many cases, were accepted by the W.O. He also found time to help in the formation of an Army Rifle Association, and a local United Services Association : Capt. Percy Scott of the *Terrible* belonged to the latter.

In January, 1904, Baker Brown sailed for home but was recalled, on arrival at Singapore, owing to the outbreak of the Russo-Japanese War, to assist in the revision of the Defence Scheme, then in progress. He stayed on, attached to the General Staff, until April when he came home via Canada. On arrival the D.F.W., Col. R. M. Ruck, brought him into the War Office to take over the duties of Inspector Submarine Defences. About this time, however, it was decided to hand these over to the Admiralty ; and both found themselves on Sir Evelyn Wood's Committee for the re-organization of the whole fortress service. When this task ended Baker Brown remained at the W.O., as I.E.L., to find the whole work of revision of equipment and mobilization tables for R.E. Units just handed over to his branch of the Directorate by the A.A.G. All these changes in equipment led naturally to many alterations to the vehicles of Field Units which were worked out by the I.E.L. and the A.O.D. together. In addition all the papers dealing with the Air Services, balloons, kites and wireless telegraphy came through his branch.

Before leaving the W.O., in 1908, he managed to rewrite the *Searchlight Manual* and finish the draft of *The History of Submarine Mining*. In September he was posted to Malta as C.R.E. East Sub-District and O.C. Companies, R.E. The Duke of Connaught, then High Commissioner of the Mediterranean, had his Headquarters in the Palace, and naturally the social life was very full. That winter ('08–'09) Malta was visited by King Edward VII, Queen Alexandra, and the German Emperor. Baker Brown took his full share in the activities involved, ran the Rifle Meeting, and served as Church Warden of the Garrison Church. On the Works side the provision of new married quarters, electric lighting in all barracks, and the adaptation of casemates to furnish more barrack accommodation formed the major part of his responsibility.

In August, 1912, he was promoted Colonel, with one year's antedate. On arrival home the prospect of fifteen months on half-pay greeted him, but those who knew him and his wide range of knowledge and interests, will not be surprised to learn that he obtained some employment in connexion with Civil Service examinations at Burlington House, in addition to writing for the Service Journals, which had always been his hobby.

At the end of 1913, he was appointed Chief Engineer, South China Command, and arrived, at Christmas time, with his wife and youngest daughter Winnifred, to take over from Col. St. John. There the writer of this Memoir, then a Subaltern in the 40th Coy. and Asst. O. i/c. E.L. & T. (The telephones were still in R.E. charge), met him for the first time. " B.B.", as he was affectionately known, entered at once, with whole-hearted enthusiasm, not only into the work of the Colony but also into its many social and sporting activities, ably seconded by Mrs. " B.B." a kindly and soon a very popular hostess.

Golf, bathing and sailing were his keenest interests during the leisure hours of a great worker. The writer often acted as crew for him in the R.E.Yacht *Kathleen*, and for his daughter in the ladies' races.

At the end of July, 1914, work began in real earnest as we were ordered to put the precautionary phase of the defence scheme into action. By the time

Tsing-Tau had fallen everything, including greatly augmented telephone communications, was so far advanced that the C.E. could press his claim to return to England, as many other Regulars were now being sent home, or to the Middle East. The G.O.C., himself a Sapper, could not officially spare him but allowed him to write " D.O." to the D.F.W., Scott-Moncrieff! The result was that March, 1915, saw our late C.E., settled in as Chief Engineer Eastern Command. The Command was expanding rapidly; it had a full hutting programme for Kitchener's Army and, as a further complication, housed the " Central Force," an Army Group under Sir Ian Hamilton, and later under Sir Leslie Rundle. Shortly all the administrative services of this group came under the C.E. Eastern Command.

In 1916, when the command had settled down, " B.B.", was able to go overseas as D.D.W., B.E.F., France, for the control of Engineer Stores, an appointment in which his previous experience at the War Office was of great value. At that time G. K. Wait and E. S. Sewell were his A.D.F.W.s. In 1917 he received a well earned C.B. Next year he left France to take up the last, and probably most difficult, appointment in the whole of his varied career, i.e. C.E. Irish Command. This post he held for three stormy years, but unfortunately he has left no record behind of this period.

In 1921, he retired, after thirty-eight years' service, which many will agree was hardly appreciated at its full worth. On retirement he devoted himself chiefly to writing, both for the *Pickaxe* and other Service Magazines, but his *chef-d'œuvre* was Vol. IV of the Corps History, now ready for the press. He had always been a prominent member of the Army Officers Art Society and put in much good work on this pleasant hobby during his retirement, one charming water-colour of his, Wallingford, is now in my possession.

For many years he was a prominent speaker at all meetings of the Widows Fund, urging that a less conservative view be taken of increasing the pensions. His views gave rise to some controversy, but there was never any difficulty in obtaining a quorum for the meeting when " B.B." was up. This year the Chairman, when referring with regret to the General's passing, paid a tribute to the value of his trenchant criticism in the past.

He was laid to rest on Friday, 9th May, in his father's grave in St. Mary's Churchyard, Caterham, and leaves a widow, and three daughters all married. Among his grandchildren, one, Major D. W. B. Williams is in the Corps.

" B.B." was a man of wide interests, and many gifts which might escape notice except among those who knew him well since he was, by nature, very modest and somewhat shy. The writer will always be grateful to him for the great help he gave to him when Secretary of the Institution; both by advice and by providing valuable copy during a very lean period. A very able, kindly and generous gentleman, who loved the Corps, has left us.

H.M.F.

BRIGADIER-GENERAL J. A. GIBBON, C.M.G.

JAMES AUBREY GIBBON, son of Canon W. W. Gibbon, of Ripon, was born in 1864. After education at Haileybury College and the R.M.A. he received his first commission in the Royal Engineers in 1884.

His early service was passed in India, where he took part in the Tirah campaign, receiving the medal and two clasps.

In 1901 Gibbon returned to England to take up command of the 60 Field Coy. at Aldershot, transferring in 1903 to command the 17 Field Coy. This carried with it the duties of D.O.R.E. South Aldershot, a heavy works charge, superimposed on his military duties.

Gibbon was a great believer in carrying through works by directly employed labour—military or civil, or preferably a combination of the two. He believed that only in this way could young officers and N.C.O.s obtain that training in practical design, the wise use of materials and the handling of labour which is essential as a preparation for war

It is not easy in peace-time to obtain sanction to carry out works by direct labour. Economy is then the ruling factor and it is not easy to persuade Higher Authority to sink capital in plant and to set up an organization, so long as they feel that work might be more cheaply carried out under the contract system.

As a Company Commander, Gibbon could only start in a small way and even then only by a somewhat rough handling of the Regulations. But in his eyes Regulations were made for man and not man for Regulations and fortunately he could justify his policy by its results.

This he did by a careful and constant use of labour constants. To Gibbon, the man-hours, whether on drill, field training or military works, were precious things—talent not to be buried in the earth, but to be used to produce the utmost. By constant competition he would screw the utmost out of everyone until he arrived at what he considered was a high standard—and his standard was very high.

In 1906, Gibbon was appointed Major of the Training Battalion at Chatham, a post which enabled him further to develop his system of constants of labour on purely military jobs. In 1908 he took over duty as C.R.E. Lands. Here he inherited a system of labour employed directly in the maintenance of roads in the Aldershot Command. These were still the old high-cambered, gravel, water-bound roads of the pre-motor age. Interpreting maintenance in its broadest sense he carried out a scheme of reconstruction with modern kerbing and surfacing.

In 1910, Gibbon became C.R.E. 2 Div., which was commanded by Maj.-Gen. (later Lieut.-Gen. Sir Henry) Lawson, a distinguished Sapper Officer. The R.E. 2 Div. of that day comprised the 5 Field Coy., the 11 Field Coy. and the 2 Divisional Telegraph Coy. To the appointment of Divisional C.R.E. was added that of C.R.E., South Aldershot. This was a particularly heavy works charge including three regiments of cavalry, two brigades of artillery, eight battalions of infantry, Gibraltar Barracks, practically the whole of the Services and Establishments of the Aldershot Command, the Cambridge Hospital, the Royal Pavilion, four churches and hundreds of Married Quarters. This meant that far too much of the Divisional C.R.E.'s time was taken up in Works. Here Gibbon was able to put into full practice his ideals for achieving efficiency and economy in the training of the sapper officer and man. By continual analysis of labour constants and a rigid insistence on keeping the labour both of soldiers and civilians up to his standards, he succeeded in reducing building costs, as measured by the

cubic rate, to a level which was the despair of contractors. Using the methods of construction, advocated by Major-General Scott-Moncrieff (4½ in. brickwork rendered inside, rough-cast outside, built-in panels between stanchions) he reduced the cost of stabling (if the writer's memory is correct) to under £20 a horse or £25 a charger. And he had the foresight to bear in mind that the design had to be susceptible to conversion to garages at a later date.

His late Majesty, King George V, at an inspection was so pleased with the results that he directed that the plans should be forwarded for the information of the officers of his household.

Gibbon's tenure of command coincided with the period of intensive training precedent to the Great War. During collective training his technical advice in the preparation and carrying out of schemes involving engineer considerations was greatly valued by his Divisional Commander.

He gave up command in 1913 and was appointed C.E., Aldershot Command in the following year.

In 1915 he was C.E. VIII Corps, Gallioplí and Egypt. Unfortunately the writer of this Memoir has not the material available to touch on his work during this campaign.

In 1916 Gibbon was appointed C.E. Southern Command at Salisbury, where he remained until his retirement in 1920, receiving the C.M.G. for his services in 1919.

If one were asked to describe Gibbon's character one might say that he was always desperately and restlessly earnest. A devout and sincere Christian, he was earnest in his religious exercises, as he was also earnest in the practice of the military art and of the science of engineering.

No officer or man could have served under him without feeling his strong personality and no officer or man could have been trained by him without realizing in later years how much he owed to Gibbon's methods.

He married in 1894 Madeleine Louise, daughter of E. M. Denny, Esq. by whom he had two sons and a daughter.

Gibbon died in 1947 at the age of 82.

R.A.B.

COLONEL H. S. BRIGGS, O.B.E.

HENRY STACPOOLE BRIGGS ("Phil") was the elder son of Henry Bremridge Briggs and was born in London in May, 1891. From the Merchant Taylors' School he passed into the "Shop" and was commissioned in the R.E. in December, 1910. Having completed the usual two years' training at the S.M.E., Chatham, he spent a year at the (old) North Eastern Railway workshops at Darlington, undergoing a "Mechanical Course" after which he joined 33 Fortress Coy., R.E. at Queenstown in 1914. On the outbreak of war he was transferred to 32 Army Troops Coy. and proceeded to France where that unit was detailed for the running of the Engineer Base Stores Depot and Workshops at Havre. Here Briggs, still a comparatively junior officer, had charge of the setting up and operation of the extensive workshops, and gave early proof of his drive and bent for organization. He was promoted substantive captain in 1916, and appointed Field Engineer for water supply duties, with the acting rank of Major, on the Staff of Major-General P. G. Grant, Chief Engineer, Fifth Army. In this capacity during the next two years, first on the Somme and later in the Ypres Salient, Briggs was conspicuously successful in grappling with the difficult problems involved in supplying pure water in adequate quantities to the enormous concentrations of troops and horses in areas which were either waterless (as the plateaux above the Somme) or where the sluggish streams were heavily contaminated (as in the Ypres Salient). He was undoubtedly the pioneer of the large scale use in the field of deep drilled tube wells, worked by air lift pumps, and of the, then, little known field process of sedimentation, mechanical filtration, and gas sterilization.

For his services in the war Briggs was awarded the O.B.E. and given a brevet majority.

In 1919 he was posted home to the (then) School of Electric Lighting, Gosport, where as Instructor (Mechanical), with his customary energy, he soon had modernized the teaching installations and the system of instruction on the mechanical side. In 1922 he accompanied his old chief, Maj.-Gen. Sir P. G. Grant, to Palestine, where Briggs was employed as A.D. Public Works. He returned to England in 1924 and underwent an advanced E. & M. course, on conclusion of which he was appointed D.A.D.F.W. for E. & M. duties at the War Office at a period when great expansion in E. & M. activities was in hand. He remained there till 1929, after which he did a year as Company Commander in No. 1 Anti-Aircraft Searchlight Bn., R.E. at Blackdown. He went to Chatham as Chief Instructor of the E. & M. School in 1930—a job after his own heart for which he was eminently suited. Soon after his promotion to Lieut.-Col in 1934, he went to Jamaica as C.R.E. Returning home in 1938, he was C.R.E. at Preston until he was placed on the unemployed list, but was almost immediately appointed Joint Secretary of the Supply Board, transferring later to the Ministry of Production, where he remained until retiring at the end of 1944, having been promoted Colonel as from December, 1939. He then joined the British Tabulating Machine Company at Letchworth in a civilian capacity as works director, and while in harness died on 31st May, 1946, after a short illness.

He married, in 1930, Miss Heartsease Stanier (daughter of Ernest Stanier, Esq.), who survives him, together with his son Michael and daughter Anne.

Those who knew Phil Briggs will remember him as a very able man of deep religious feeling, a good friend, and intensely absorbed in whatever work he had in hand. An enthusiastic specialist in "E. & M." at a period in the Corps history when expansion in that direction was extremely rapid, he was throughout his service closely associated with E. & M. development and training, on which he can truly be stated to have left his mark.

H.H.B.

BOOK REVIEWS

"HISTORY OF THE GREAT WAR"

Military Operations in France and Belgium, 1918. Vol. IV

EDITED BY BRIG.-GEN. SIR JAMES E. EDMONDS, C.B., C.M.G. Hon. D. Litt. (Oxon.), late R.E., p.s.c.†.

(Published by H.M. Stationery Office. Price £1 7s. 6d.)

The publication of this volume, which follows on from Volume III, published in March, 1939, has been delayed owing to the second world war. It covers the period 8th August to 26th September, 1918, and describes the opening moves of the offensive by the Fourth Army (which contained the Canadian and Australian Corps), the attacks carried out by the First and Third Armies and the subsequent advance by the Second and Fifth Armies, bringing the whole allied line up to the famous Hindenburg Positions by the 26th September. This very important phase of operations led up to the final assault and disintegration of the German Armies.

The general arrangement of this volume is on similar lines to those previously published, but owing to the very large forces engaged it has been necessary to restrict the details of the various engagements except in certain specific cases.

There are 23 Appendices containing Orders of Battle, Operation orders and instructions and a very interesting memorandum, issued by the C.I.G.S. on 25th July, 1918, containing particulars of "British Military Policy," "Preparations for the Offensive," "Principles of Organization" and notes on the "Situation of the British Empire after the War."

There are also 30 situation maps and four larger maps.

This is a most valuable addition to the historical records of the 1914–18 War.

C.C.P.

"RUSSIAN BY YOURSELF"

BY L. S. MILLER

(G. Bell & Sons, Ltd. Price 8d. 6d.)

In spite of the optimistic view expressed by the author about the ease of learning the Russian language it is certainly a most difficult tongue to master. Nevertheless I think it is made as easy as possible by this book and the difficulties are set out clearly and well explained. The results of teaching Russian at the R.M.A., Sandhurst remain to be seen but some of the cadets may feel inclined to continue their studies for the considerable time that is needed for this purpose. In their case this book will certainly help them. They will have learnt Part I at Sandhurst, but Parts II and III will definitely help them in their studies after they have left the Academy.

G.leQ.M.

"PLAYING WITH STRIFE"

By Lieut.-Gen. Sir Philip Neame, V.C., K.B.E., C.B., D.S.O.
(Harrap & Co., Ltd. Price 15s. 0d.)

Well might the author of this adventurous autobiography claim to have "done something all round." He has a good memory and tells his story of hard work and hard play in an engagingly straightforward way. He obviously regards all hazards as part of the game, occurring only to be overcome by a cool head and a straight eye, and certainly not to be made much of. He unbends so far as to admit that on one occasion German snipers gave him "frequent cause for concern" that a certain rock-face in the Shigar Valley of Baltistan was "hair-raising"; (one glance at the photograph would be enough for most people); and that being mauled by a wounded tigress is "exciting."

In the book are many quotations. If the reader were to add one to their number:—

"What has the General done, said I,
What has the General done?"

the answer would be briefly as follows.

As a subaltern in the 56 Field Coy. he won places in the Army Rifle Eight and the Revolver Thirty; went for a flight in the first Bristol biplane, sitting in front with legs dangling in space; and with *Sonia* won the R.A. Harrier Hunt Cup three years running, as well as several point-to-points.

At Gibraltar he played No. 1 in the winning Regimental and Subalterns' polo teams. Two months after landing in France with the 15 Field (formerly Fortress) Coy. he won the Victoria Cross at Neuve Chapelle for an almost single-handed bomb fight, and for rescuing wounded men. He rose to be G.S.O. 1 of a division and after the War was a teacher at the Staff College and later Brigade-major at Aldershot.

He has shot chamois in the Pyrenees, mouflon in Sardinia, wild boar in the Carpathians, and Spanish ibex in the royal reserve in the Sierra de Gredos. He has played hockey for Kent and the Army; has ski-ed in Norway and Switzerland; has won numerous point-to-points; has mountaineered with F. S. Smythe; and has shot for the British Empire in the Olympic Games.

He spent twelve years in India, starting in the Bengal Sappers and Miners, becoming G.S.O. 1 Waziristan and finally B.G.S., Eastern Command. During this time he did all there was to be done, shot everything, and went everywhere, including Tibet, where he was a member of a unique mission.

Then he was Commandant of "The Shop." In the recent War he was Deputy C.G.S. to Lord Gort in France; Commander of the 4 Indian Div. in the Western Desert; G.O.C. Palestine, Trans-Jordan and Cyprus; and finally G.O.C.-in-C. Cyrenaica at the time of the thinning-out of our forces for the Greek expedition. In April, 1941, he and Lieut.-Gen. O'Connor were made prisoners by a German patrol.

The book was written during captivity in Italy and the manuscript had some adventures of its own before being recovered from the monks who had faithfully concealed it from the Germans. But, in addition to writing a book, it goes without saying that Philip Neame was busy arranging to escape, and his account of life in the Generals' Camp (otherwise the Castello di Vincigliata, near Florence), with its exploring and measuring and tunnelling, reads like a John Buchan tale come true.

It is hardly necessary to add that this is a stimulating and welcome book. There are several good photographs, mostly taken by the author himself.

I.S.O.P.

"GEOGRAPHICAL BY-WAYS"

By Sir Charles Arden-Close

(Edward Arnold & Co. Price 7s. 6d.)

Some years ago, *The R.E. Journal* published a paper, unfortunately now out of print, by Sir Charles Arden-Close on "The Early Years of the Ordnance Survey." Those who read and enjoyed it will, we hope, be equally pleased with this book.

Most of the twelve essays included in it have already appeared in various journals but we are extremely glad that they should have been collected together and re-published. Each essay is the result of much study and is presented in a style which will not only grip the attention but also stimulate the reader to dig more deeply into the subjects the author has chosen.

The book is divided into two parts, in the first of which there are nine essays. In "Wandering Continents" the alleged westward drift of Greenland is examined. If this were proved it would confirm the Wegener theory of movement of land masses. The discrepancy between the longitudes observed in 1863, 1882 and 1922 is only about the probable error of the earlier observations. There is no apparent movement in latitude. It is doubtful, therefore, if there has been a shift but the observations should be repeated presently to confirm this judgment.

"The Levels of Land and Sea" presents a clear picture of the difficulty of proving whether the surface of the land is rising, falling or tilting with respect to the surface of the sea. It deals with the factors which must be taken into account in computing sea-level. At one time the Ordnance Survey operated tidal stations at Newlyn, Dunbar and Felixstowe, but the last-named fell under the Geddes axe and was closed some years ago. The old levelling of 1840–60 is too unreliable for use as a comparison to show whether there has been any movement. The re-levelling of 1912–21 is of sufficiently high precision for comparison with a repetition in, say, 50 years time. To ensure that the maximum value can be obtained from such a work it is most desirable that the Felixstowe station should be re-opened.

The essay on "The Rainfall of Palestine" is topical and well worth reading. It brings out clearly how closely related the rainfall is to the height and nearness of land to the Mediterranean.

Other essays—all of them of interest—deal with the Old English Mile, the Antipodes, the Horizon, the Geographical Centres of England and Wales, Map Projections and Map References. Space, unfortunately, does not allow of a detailed criticism of each.

In the second part there are three essays two of which are of outstanding importance for they tell the story of the International Map of the World and of the fifteen International Congresses held between 1871 and 1938. No one is better qualified than the author to record this history in the making of which he has played such a large part. Those who may have to deal with either subject will find these two essays a great help in an understanding of the past.

The third essay deals with Space, Food and Population. It studies the growth of the population of Great Britain and the amount of food that might be grown at home. Today, with the American loan running out fast, this essay will be of the greatest interest to all who are thinking of their Country and what the future holds for it.

We congratulate the author on this book which cannot but be of interest to everyone who is fortunate enough to get a copy and we hope that it will soon be followed by another volume.

K.M.P.

"AN INDEX OF MATHEMATICAL TABLES"

By A. Fletcher, J. C. P. Millar and L. Rosenhead.

(London Scientific Computing Service, Ltd., 1946. Price 75s. 0d. Pp. vii., 450.)

Every R.E. officer has at least some acquaintance with a few mathematical tables, if only of logarithms, and there must be a considerable number who, when confronted by some apparently new problem, have wondered "Is there no existing table giving the values of such and such a formula to so many significant figures?" They may have felt impelled to compile a table for their own use, perhaps to publish one, and later on have discovered that a similar and better table was already obtainable.

The book named above is the complete answer to such questions and will obviate similar disappointments in future. It has been reviewed most favourably by the mathematical press on both sides of the Atlantic; a few extracts are printed below. Quite apart from its serious uses, no one, however weak in mathematics, can fail to be fascinated by the vast amount of laboriously acquired information that has now been sorted out, classified and so arranged that even a novice can see at a glance what already exists and where to look for it.

Proceedings of Physical Society, Vol. lvii, page 492. "The need for the volume is really very great, and as far as can be judged without a year or so of trial, it has been extremely well done . . . To say that every scientific library needs the book is an understatement. It should . . . be bought by as many working mathematicians and mathematical physicists as possible."

The Mathematical Gazette, July, 1946. "But there has been an obvious need for an index, full, systematically arranged in a single volume, and thoroughly reliable. This we now have in the present admirable work . . . All who use mathematical tables must ensure that this volume is readily accessible; it is an indispensable adjunct to any library, public or private, of scientific pretensions."

Mathematical Tables and Aids to Computation, Vol. ii, No. 13, January, 1946, printed in U.S.A. "Thus the *Index* is an indispensable tool for every university library, and for every research center where computing is carried on extensively. . . . The extraordinary accuracy and comprehensiveness of the work, compiled during five or six years, when the authors were also making their contributions to the war effort, must excite profound amazement on the part of anyone who has attempted something of a similar nature."

A copy of this *Index* is now in the Corps Library.

S.H.C.

"SECOND YEAR RADIO TECHNOLOGY"

By W. H. Date, B.Sc.

(Longmans. Price, 7s. 6d.)

Within the scope set by the author, this is a useful and practical book. The would-be reader should be advised, however, that its main theme is the commoner types of valve-circuit. Nine of the fifteen chapters are devoted to this. The other six chapters are somewhat slender, especially the one entitled "Principles of Radio Communication" which contains barely any reference to propagation in all its aspects. This criticism is not necessarily

adverse ; in 214 pages it would be impossible to cover much more ground than the author has done, but it is important to realize that much other ground remains.

The chapters on valve-circuits handle the subject very adequately. Typical values for the components are usually stated, which will be a boon to the learner-experimenter. All the commoner types of valve are described, with their usual circuits. There is no reference to the more special types, such as the magnetron, used in modern ultra-high-frequency work. Automatic gain-control deserves more explanation than the brief reference on p. 133.

For following the numerical work, the reader needs no mathematical equipment beyond a knowledge of simple graphs and algebra, and the elements of trigonometry.

The book is well provided with diagrams, and at the end of every chapter there are some useful examples, mainly from the City and Guilds examinations. In the chapter on " R.F. Instruments and Measurements " one would have liked to see included the cathode-ray tube which is such a potent modern means for disclosing exactly what is happening in a radio circuit. The chapter on Direction-Finding might have included at least a passing reference to the Adcock and spaced-loop systems. Frequency-modulation (" F.M.") is not mentioned anywhere.

The style is, on the whole, clear. Occasionally, however, the author runs two sentences into one, with unfortunate results. He also uses the word " when " in contexts that make it ambiguous ; for instance, on p. 106 :— " For certain specific purposes gas may be deliberately introduced at very low pressure when the control action exerted by the grid is vastly different from the case (*sic*) of the vacuum triode." Is the gas introduced because the control action is different, or vice versa ?

There are a few misprints. Most of them are self-evident, but we must mention that in Fig. 107 there should be no connexion between filament and grid ; and the formula on p. 152 holds good only when h is less than $\frac{\lambda}{4}$.

There are several directions from which the initial approach to Radio may be made. That of valve-circuits is probably as good as any. To those who adopt that particular approach, this book can be recommended.

N.H.E.

THE ROYAL MANX FENCIBLES

By B. E. Sargeaunt, M.V.O., O.B.E., F.S.A.

(Published by Gale and Polden. Price 10s.)

Fencible Corps were formed in the eighteenth and early nineteenth centuries to provide troops at home to take the place of the Regular Army when it went overseas during the various campaigns of that period.

This small book gives particulars of four such Corps formed in the Isle of Man and will be of interest to all Manxmen.

It is also interesting to note that the first Manx Fencible Corps, raised in 1779, was commanded by an R.E. Officer, Lieut.-Col. Richard Dawson, who was Lieut.-Governor of the Island at that time.

C.C.P.

MAGAZINE REVIEWS

NOTE

In future issues of *The R. E. Journal* it is proposed to substitute short technical notes in the place of Magazine Reviews. These notes will give references to interesting articles appearing in various magazines on all branches of engineering work including Transportation, Survey, and Materials as well as those coming under the ordinary headings of Civil and Mechanical Engineering.

JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA

(Published by the United Service Institution of India, Simla)

January, 1947.—*A Panorama of India's War Potential.* A lecture by Maj.-Gen. E. Wood on India's war supply effort. The history of war supply in India is traced from the time of Barbar through the 1914–18 war up to the end of the last war and deals in detail with the magnificent effort made by India to meet all demands. The lecturer brings out the necessity for the Finance Department to control prices and profits, for giving all officers powers equal to their responsibilities and to build in peace a sound organization with a trained supplementary reserve of officers drawn from industry.

India at the Paris Peace Conference, 1946. A clear summary of each of the peace treaties with the results of the main problems which came up for discussion by an officer who attended the peace conference.

A Day with the "Plebes"—at West Point. An interesting account of what a new cadet joining the U.S.A. Military Academy, West Point, has to do on his first day.

A Long Term Administrative Plan for India. The first instalment of this article deals with suggestions to neutralize the threat of atomic weapons by planning the administrative layout to give the maximum protection to principal industries and their personnel.

The Defence of the Indian Ocean and the Far East. A study of the defensive problems in the far east assuming that for purposes of major military operations the British Commonwealth and United States are one.

Take a Look at the Map-makers. Gives the main features of the organization and the principles on which the Survey Service in India Command work. The making and distribution of maps in war is described in detail.

April, 1947.—*New Weapons for Old.* Outlines the steps that have to be taken in selecting a new weapon for the forces. The first essential is a detailed analysis of the users "needs" looking well into the future. The necessity for frequent user and technical trials is stressed.

How America Organizes her Armed Forces. An interesting article on a subject little understood by the average officer.

Chaplains in India—the Story of the I.E.E. Traces the history of the Indian Ecclesiastical Establishment from 1607. The debt the British soldier and civilian owe to the chaplains is well brought out.

A Long Term Administrative Plan for India, The second instalment of this article deals with air transport and indicates the types and numbers of aircraft which might be required and the organization of rear and forward airfields.

How a Nation Massed for War. Recapitulates for Indian readers the major steps in the mobilization of the United Kingdom to undertake total war.

C.G.M.

THE ENGINEERING JOURNAL

(Published monthly by The Engineering Institute of Canada)

February, 1947.—*Oxygen Accelerated Combustion in Open Hearth Furnaces.* The operations of steel welding and cutting require relatively small volumes of the gas. A cheaper method of production now makes it practicable to use the gas to increase the combustion rate and shorten the scrap metal melting time in furnaces.

Analysis of an Arch-supported Continuous Girder. The author gives the mathematical theory of the design and considers this type of structure to be very suitable for bridges with spans of 300 to 600 ft.

Research Council Reconverts to Peace. This article deals with the various post-war activities of the National Research Council of Canada.

March, 1947.—*Canada's Synthetic Rubber Production.* The author traces the early development in synthetic rubber production in Germany and America and the further accelerated development in Canada since natural rubber almost disappeared with the Japanese conquest of Malaya in 1942.

The Principles of Pre-stressed Concrete. A short non-mathematical article by a Belgian engineer who expresses the opinion that in the near future, all concrete bridges will be built on pre-stressed lines. Three methods of pre-stressing are explained.

Large Scale Housing—Its Planning and Construction. This paper deals with the New York Housing Authority's large scale housing schemes, comprising large blocks of flats up to a height of 14 storeys. Methods of effecting economies are described, by standardization, the use of controlled concrete and the elimination of non-essentials.

Certain Aspects of Frequency Modulation and Television Broadcasting in Canada. The inherent advantages of frequency modulation compared with amplitude modulation (used commercially at present) are explained. The prospects of television broadcasting in a large sparsely-populated country like Canada are not very promising.

April, 1947.—*Application of the Cylindrical Shell for Concrete Roofs.* The basic principles of design are described and their application to roofs and pipes are illustrated.

The Smoke Problem. This is a general discussion of the problem in densely populated areas. It is pointed out that a human being requires 30 lb. of air a day compared with 2·7 lb. only of food and 4·5 lb. of water. Relatively little attention is paid to rendering the air innocuous.

Steel Rail Piles replace Concrete. An example is given in which 16 in. diameter cast-in-place concrete piles were driven in soil having a substrata of soft clay below a hard clay layer. The piles waisted in the form of an hour glass below the hard clay, due evidently to the driving of adjacent piles. Various alternatives were considered but the most satisfactory solution was found to be the use of steel piles made by welding together the flanges of three 60 lb. or 75 lb. rails.

Recent Highway Developments in Ontario. This article deals with the modernization and repair of the roads and highways in the province (the Toronto–Barrie highway in particular) which have greatly deteriorated during the war years.

W.M.

CORRESPONDENCE

Spring Cottage, Churt, Surrey.

The Editor,
The Royal Engineers Journal.

Dear Sir,

"EARLY BRITISH ENGINEERS"

Is the writer of the interesting article under the above title in your March number historically accurate when he speaks of the "mistaken idea" that the English are primarily Anglo-Saxon and that "the Saxons . . . with one accord took British wives"?

The greatest living historian, G. M. Trevelyan, takes the opposite view. In his *History of England* he says "As fast as their conquests were made good, the Anglo-Saxons brought over increasing numbers of their own women and children. The tradition in Bede's time was that the whole 'nation of Angles' had made the voyage, leaving empty the land whence they came." Again "the traces of Celtic in the language that was spoken in Saxon England are negligible, being confined to half a dozen words." Such linguistic evidence hardly supports Mr. Garway's statement about the Saxons taking British wives.

Is he perhaps supporting the present Fleet Street extravagance that no such people as the English exist?

(Sgd.) E. St. G. Kirke, Colonel.

The Mount, Stromness, Orkney.

Dear Sir,

To answer Col. Kirke's last question first: I am not knowingly supporting any current theory: the conclusions are entirely my own.

The passage in Trevelyan quoted ends—"These things taken together imply a great alteration in racial stock, though the completeness of the racial change has sometimes been exaggerated." The word "imply" conveys he was judging from indirect evidence.

As far as I know the only direct evidence that any Anglo-Saxon women were brought over is the Anglian tradition quoted, and Nennius "some islands whence they came were left without inhabitants," also Wace's story of Hengist's daughter. On the other hand Gildas uses the expression of later numbers joining "their bastard born comrades," which suggests the view I have taken; and Nennius further on speaks of "military bands" from all parts of Germany, without mention of wives. For the following reasons I think that although some Anglo-Saxon women came over, it was not many.

The two main reasons are these. Firstly, all our nursery stories and rhymes are Celtic, except for a few Norse; I cannot think of a pure Saxon one; this indicates British not Saxon mothers. Secondly, at the rebirth of a national spirit under Edward I—III, the popular traditions were Celtic, e.g., the national banner of St. George, the romances of King Arthur and the belief he would come again, and the Garter revival of the Round Table. All the royal emblems are Celtic and tell the same story; the kings were identifying themselves with the people, and its predominant strain was British, not Saxon.

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Yours faithfully,
(Sgd.) John Garway.

It is regretted that space does not permit of printing Mr. Garway's letter in full or any further correspondence on this subject and members must decide whether to accept Trevelyan's well recognized authority or Mr. Garway's interesting personal views.—Editor.

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EXCLUSIVE TO THE SERVICES

Design a new badge for NAAFI and win a prize in this Services-only £200 Competition.

You are familiar with the present symbol (it is shown above) in which you will have spotted the Navy, Army and Air Force elements. NAAFI is looking for a new badge — one which will be suitable to appear outside Clubs and Canteens, to serve as a direction board, and for all similar purposes. The competition is exclusively for all serving Sailors, Soldiers and Airmen, and WRNS, ATS, and WAAF. Entries may also be submitted by men and women of the three Services who will be on demobilisation Release Leave on 31st October, 1947.

THE CLOSING DATE FOR THE COMPETITION IS 31st October, 1947, after which no further entries will be considered. Results will be announced in this journal.

Entries should be sent to the Public Relations Officer, NAAFI., Ruxley Towers, Claygate, Esher, Surrey.

Entries will be judged by a panel of experts and their decisions will govern the award of the following prizes:—

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Second Prize	... ...	£ 50
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RULES

1. The design must be capable of reproduction on paper, in wood or metal, or as a stencil.
2. Each entrant may submit up to three designs.
3. Competitors may prepare designs in pencil, crayon, ink or paint.
4. Entries will be judged on the following qualities —
   (*a*) Shape; (*b*) Colour; (*c*) the incorporation of the letters NAAFI; (*d*) Motif.
   As a guide, the Shape should be bold, recognisable at some distance, and likely to be easily remembered.
   Colour; there is no restriction in the use of colours but entrants will no doubt bear in mind the Navy blue, Army scarlet and Royal Air Force blue as suggesting a suitable colour basis.
   NAAFI; the letters NAAFI (without full points) should be incorporated into the design and be immediately readable.
   Motif; this should symbolise the NAAFI's service to the Royal Navy, Army and the Royal Air Force.
5. Designs may be of any size, although 12 ins. by 12 ins. is suggested as convenient limit.
6. The Number, Rank, Name and *permanent* address of the competitor must be written on the back of each entry submitted.
7. The judges' decision will be final and no correspondence in connection with the competition will be entertained.
8. Proof of posting will not be accepted as proof of delivery.
9. NAAFI does not guarantee to adopt as its official badge the winning design, or any design, submitted in this competition.
10. NAAFI reserves the right to reproduce the designs of all prize winners. Unsuccessful designs will be returned to the entrants.

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