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ROYAL ENGINEER OFFICERS WHO HELD GENERAL

On the outbreak of the war in 1939 the R.E. had less than 1,200 serving produced 80 General Officers during the war, i.e., nearly one in every seven. branch of the Army. In view of the pre-war restriction upon the numbers of officers for purely engineering appointments, this is an achievement which

The following alphabetical list has therefore been prepared showing those " Stop-gap " appointments of short duration have been omitted. It is hoped corrections.

Rank	Name
Major-General	A. V. ANDERSON, C.B., M.B.E.
Lieut.-General	Sir CLARENCE A. BIRD, K.C.I.E., C.B., D.S.O.
Lieut.-General	Sir LIONEL V. BOND, K.B.E., C.B.
Major-General	R. L. BOND, C.B., C.B.E., D.S.O., M.C.
Major-General	N. C. D. BROWNJOHN, C.B., O.B.E., M.C.
Major-General	A. G. B. BUCHANAN
Major-General	A. M. CAMERON, C.B., M.C.
Major-General	W. CAVE-BROWNE, C.B.E., D.S.O., M.C.
Major-General	G. CHEETHAM, C.B., D.S.O., M.C.
Lieut.-General	Sir DUDLEY S. COLLINS, K.B.E., C.B., D.S.O.
Major-General	N. A. COXWELL-ROGERS, C.B., C.B.E., D.S.O.
Major-General	K. N. CRAWFORD, C.B., M.C.
Major-General	A. E. DAVIDSON, C.B., D.S.O.
Major-General	P. de FONBLANQUE, D.S.O. (*Since deceased*)
Major-General	R. H. DEWING, C.B., D.S.O., M.C.
Major-General	B. E. C. DIXON, C.B.E., M.C.
Lieut.-General	Sir WILLIAM G. S. DOBBIE, G.C.M.G., K.C.B., D.S.O.
Major-General	A. C. DUFF, C.B., O.B.E., M.C.
Major-General	H. S. GASKELL, C.B., D.S.O.
Lieut.-General	Sir A. EDWARD GRASETT, K.B.E., C.B., D.S.O., M.C.
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Major-General	A. W. HOLBROOK, C.B.E., M.C.

OFFICER'S RANK DURING THE WORLD WAR 1939–1945

regular officers of which 565 were of Field rank and above. These 565 officers
They held command and very high staff appointments in practically every
R.E. officers entering the Staff Colleges, and of the very great demands for
should be recorded.
who held General-officer rank between the declaration of war and VJ day.
that this list is complete but the Editor would like to receive any additions or

		Appointment held
.	.	D.Q.M.G., B.A.S. M.G.A., Western Command. Dir. Civil Affairs, War Office.
.	.	E.-in-C., India. M.G.O., India.
.	.	G.O.C., Malaya.
.	.	M.G.A., A.A. Comd. D.Q.M.G., India. E.-in-C., India. Fortress Comd. Trincomalee. Comd. Sierra Leone Area. Comd. Nigeria.
.	.	D.Q.M.G., Home Forces. M.G. " Q," C.O.S.S.A.C. Dep. Asst. Chief of Staff (G4), M.E.F.
.	.	D.F.W., War Office.
.	.	Comd. 6 A.A. Group. M.G. Air Def., S.H.A.E.F. Comd. Special Projectile Ops. Group. D.Q.M.G. (A.E.), War Office.
.	.	Dir. of Wks., B.E.F. D.F.W., War Office.
.	.	Dir. Gen., Ordnance Survey.
.	.	D.Q.M.G. (Supply) War Office.
.	.	M.G.R.E., A.F.H.Q. C.E. 15 Army Group.
.	.	Dir. of Air, War Office.
.	.	Dir. of Mechanization, War Office.
.	.	Comd. L. of C., B.E.F.
.	.	Dir. Mil. Ops. and Plans, War Office. Chief of Staff, Far East. M.G.G.S., B.A.S. Head of Mission to Australia. Head of Mission to Denmark.
.	.	E.-in-C., M.E.F.
.	.	C.-in-C., Malta.
.	.	D.Q.M.G., War Office. D.Q.M.G., A.F.H.Q.
.	.	C.E. Home Forces.
.	.	G.O.C. Hong Kong. Comd. 48 Div. Comd. 8 Corps. Chief Liaison Officer Allied Contingents. Asst. Chief of Staff (G.5) S.H.A.E.F. Chief of Allied Contact Section. Lieut.-Governor of Jersey.
.	.	Comd. Mil. Mission to China.
.	.	Comd. 2 A.A. Div. Comd. 2 A.A. Corps. Comd. N. Wales Dist. M.G.G.S., B.A.S.
.	.	E.-in-C., S.E.A.C.
.	.	C.E., A.L.F.S.E.A.
.	.	M.G.A., Northern Comd. Member of Transport Committee.
.	.	D.Q.M.G., M.E.F.

Rank	Name
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Major-General	H. P. W. HUTSON, C.B., D.S.O., O.B.E., M.C.
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Major-General	Sir J. DRUMMOND INGLIS, K.B.E., C.B., M.C.
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Major-General	Sir MILLIS R. JEFFERIS, K.B.E., M.C.
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Major-General	J. S. LETHBRIDGE, C.B., C.B.E., M.C.
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Major-General	P. J. MACKESY, C.B., D.S.O., M.C.
Major-General	K. G. McLEAN, C.B.
Major-General	M. N. McLEOD, C.B., D.S.O., M.C.
Major-General	Sir DONALD J. McMULLEN, K.B.E., C.B., D.S.O.
Lieut.-General	Sir GORDON N. MACREADY, Bart., K.B.E., C.B., C.M.G., D.S.O., M.C.
Lieut.-General	Sir GIFFARD LE Q. MARTEL, K.C.B., K.B.E., D.S.O., M.C.
Major-General	K. J. MARTIN, D.S.O.
General	Sir EDWIN L. MORRIS, K.C.B., O.B.E., M.C.
Major-General	C. S. NAPIER, C.B., C.B.E. (*Since deceased*)
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Major-General	R. P. PAKENHAM-WALSH, C.B., M.C.
Major-General	F. S. G. PIGGOTT, C.B., D.S.O.
Major-General	I. S. O. PLAYFAIR, C.B., D.S.O., M.C.
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Lieut.-General	Sir BRIAN H. ROBERTSON, Bart., K.C.V.O., C.B., C.B.E., D.S.O., M.C.

Appointment held

Dep. E.-in-C., War Office. M.G.R.E., A.F.H.Q.

E.-in-C., M.E.F. Senior Engr. Officer S.H.A.E.F. E.-in-C. War Office.

Dep. E.-in-C., India.

Comd. 6 A.A. Div. Dep. C.-in-C., Gibraltar.

C.E., Home Forces. C.E., 21 Army Group.

Asst. Sec., War Cabinet Offices.

Director in Min. of Supply (Development of Special Weapons).

E.-in-C., War Office. Welfare Adviser to Prime Minister, Far East.

D.M.G.O., India. D.S.D., India. D.C.G.S., India. Dir. Civil Affairs, War Office. Dep. Comd., C.C.G.

M.G.G.S., A.A. Comd.

Head of Mission to Far East and Australia. Liaison Officer between S.H.A.E.F. and War Office. Maj.-Gen (Int.) C.C.G.

D.A.G., 21 Army Group.

D.C.I.G.S., War Office. Imperial Defence Committee.

D.A.G., A.L.F.S.E.A.

Dir. Gen., Ordnance Survey.

Dir. of Transportation, War Office.

A.C.I.G.S., War Office. Comd. B.A.S.

Comd., 50 Div. Comd. R.A.C. Senior A.F.V. Adviser, India. Head of Mil. Mission to Russia

M.G.A., Eastern Comd. Comd. Worcs. Sub-Dist.

D.S.D., War Office. Comd. W. Sussex Dist. Comd. 1 Div. Comd. 9 Corps. C.G.S., India. G.O.C.-in-C., Northern Command.

Chief of Transportation, S.H.A.E.F.

D.A.G., Middle East. Head of Brit. Mission to Egyptian Army.

D.C.G.S., B.E.F. G.O.C. Tps. Palestine and Transjordan. Comd. Western Desert Zone, Cyrenaica. Lieut.-Governor of Guernsey.

D.C.I.G.S., India. Comd. 18 Div. Comd. 4 Corps. Comd. 9 Corps. G.O.C.-in-C., West Africa.

G.O.C., Malta. Head of Mission to Bulgaria.

E.-in-C., B.E.F. G.O.C. Northern Ireland Dist. Comd. 9 Corps. Comd. Salisbury Plain Area. Controller-General Central Provision, Eastern Group.

Military Attaché, Tokyo.

Dir. of Plans, War Office. Chief of Staff, S.W. Pacific. Chief of Staff, Ceylon. M.G.G.S., S.E.A.C.

Comd. 23 Ind. Div. Comd. 30 Ind. Corps.

Dep. Chief Admin. Officer, A.F.H.Q. Chief Admin. Officer, Italy. Dep. Mil. Gov., C.C.G.

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Major-General	Sir HORACE E. ROOME, K.C.I.E., C.B., C.B.E., M.C.
Major-General	G. N. RUSSELL, C.B., C.B.E.
Lieut.-General	Sir RONALD MacK. SCOBIE, K.B.E., C.B., M.C.
Lieut.-General	Sir FRANK E. W. SIMPSON, K.B.E., C.B., D.S.O.
Major-General	A. W. SPROULL, C.B.E.
Lieut.-General	E. K. SQUIRES, C.B., D.S.O., M.C. (*Since deceased*)
Major-General	W. A. M. STAWELL, C.B., C.B.E., M.C.
Major-General	R. G. W. H. STONE, C.B., D.S.O., M.C.
Major-General	W. H. STRATTON, C.V.O., C.B.E., D.S.O.
Major-General	C. S. SUGDEN, C.B., C.B.E.
Major-General	Sir G. BRIAN O. TAYLOR, K.B.E., C.B.
General	Sir MORRIS G. TAYLOR, K.C.B., C.M.G., D.S.O.
Major-General	Sir EUSTACE F. TICKELL, K.B.E., C.B., M.C.
Major-General	P. A. ULLMAN, C.B., O.B.E.
Major-General	A. V. T. WAKELY, C.B., D.S.O., M.C.
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Major-General	C. A. WEST, C.B., D.S.O., M.C.
Major-General	J. F. M. WHITELEY, C.B., C.B.E., M.C.
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Major-General	B. T. WILSON, C.B., D.S.O.
Major-General	F. V. B. WITTS, C.B., C.B.E., D.S.O., M.C.
Major-General	C. G. WOOLNER, C.B., M.C.
Major-General	B. K. YOUNG, C.B.E., M.C.

ABBREVIATIONS

B.E.F.	British Expeditionary Force, N.W. Europe, 1939–40.
M.E.F.	Middle East Forces.
A.F.H.Q.	Allied Force H.Q., North Africa (Eisenhower).
C.O.S.S.A.C.	Allied Planning H.Q. for Normandy Landing.
S.H.A.E.F.	Supreme H.Q. Allied Expeditionary Force N.W. Europe (Eisenhower).

	Appointment held
. .	E.-in C., India.
. .	D.Q.M.G. (Mov. and Transportation), India.
. .	Comd. 70 Div. Comd. Tobruk Garr. D.A.G., M.E.F. G.O.C. Malta. Comd. 10 Corps. G.O.C. Land Forces, Greece.
. .	D.M.O. (and later V.C.I.G.S.) War Office.
. .	Chief Insp. Elect. and Mech. Eng., Min. of Supply.
. .	C.G.S., Australian Forces.
. .	Comd. Force 133 in the Balkans.
. .	Head of Brit. Mission to Egyptian Army. G.O.C. British Tps. in Egypt. Head of Delegation for Destruction of Enemy Installations in Liberated Areas.
. .	M.G.G.S., Austria.
. .	D.M.O., War Office.
. .	D.F.W., War Office. Insp. Fort and Dir. Bomb Disposal, Home Forces. M.G.R.E. (and later E.-in-C.) Persia and Iraq.
. .	Sen. Mil. Adviser to Min. of Supply.
. .	Dir. of Wks. and later E.-in-C., M.E.F. Dir. of Wks. and later C.E. 21 Army Group and then E.-in-C., War Office.
. .	Dep. E.-in-C., War Office.
. .	Comd. 7 Ind. Div. Comd. L. of C., Burma. Bengal Famine Relief. Dir. of Mov., Bengal.
. .	Iraq Mil. Mission. Comd. Cent. Midland Dist., U.K. Comd. Mid-West District.
. .	Comd. East Central Dist. M.G. Ops., C.O.S.S.A.C. Asst. Chief of Staff (G.3) S.H.A.E.F. Sen. Officer Co-ord. Joint Services Planning Staff for C.C.G. Chief of Army Div., C.C.G. M.G.A. Southern Comd.
. .	M.G.G.S., S.H.A.E.F.
. .	G.O.C.-in-C., Eastern Command. Mil. Adviser to Govt., New Zealand.
. .	Dir. of Freight Mov., War Office.
. .	Comd. 53 Div.
. .	Comd. 45 Div. D.C.G.S., B.E.F. Comd. 59 Div. Comd. Bombay Dist. G.O.C. Southern Army, India. Lieut.-Gov. and Sec., Royal Hospital, Chelsea.
. .	Comd. Sierra Leone Area. Comd. 81 (West African) Div. Comd. Mid-West Dist.
. .	C.E., Home Forces.

ABBREVIATIONS

S.E.A.C.	South East Asia Command (Mountbatten).
A.L.F.S.E.A.	Allied Land Forces S.E. Asia (Oliver Leese and Slim).
15 Army Group	N. Africa, Sicily and Italy (Alexander).
21 Army Group	N.W. Europe (Montgomery).
B.A.S.	British Army Staff, Washington.
C.C.G.	Control Commission, Germany.

CROSSING THE RHINE

THE TASK OF THE SAPPERS AT XANTEN

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

(Reprinted from *Army Quarterly*, April, 1946)

THE crossing of the Rhine was an operation carried out along the whole of the Allied front. It was conceived on a large scale and executed with unqualified success and great gallantry by all arms and services of the Allied Forces. From such an operation it is not easy to extract the part played by one arm of the Service and no doubt a future official history will present a true composite picture. This particular article is an endeavour to record the work of the Sappers engaged with the Corps on the right of the Second British Army's assault on that sector of the Rhine from Xanten to Vynen. It is written with full acknowledgment and in admiration for the fine team work and gallant actions of all arms and services engaged in the task.

Topography (see Map 1)

The source of the River Rhine is fed in the summer months by the melting snows and glaciers of the Swiss and Austrian Alps, and all the year round the river receives water from the drainage of the Rhine Tableland and Lake Constance through which it flows. Flooding generally occurs during the period November to March. Consequently, north of Cologne where the Rhine emerges into the plain, high floodbanks have been built on both banks continuing along its length to its estuary in Holland.

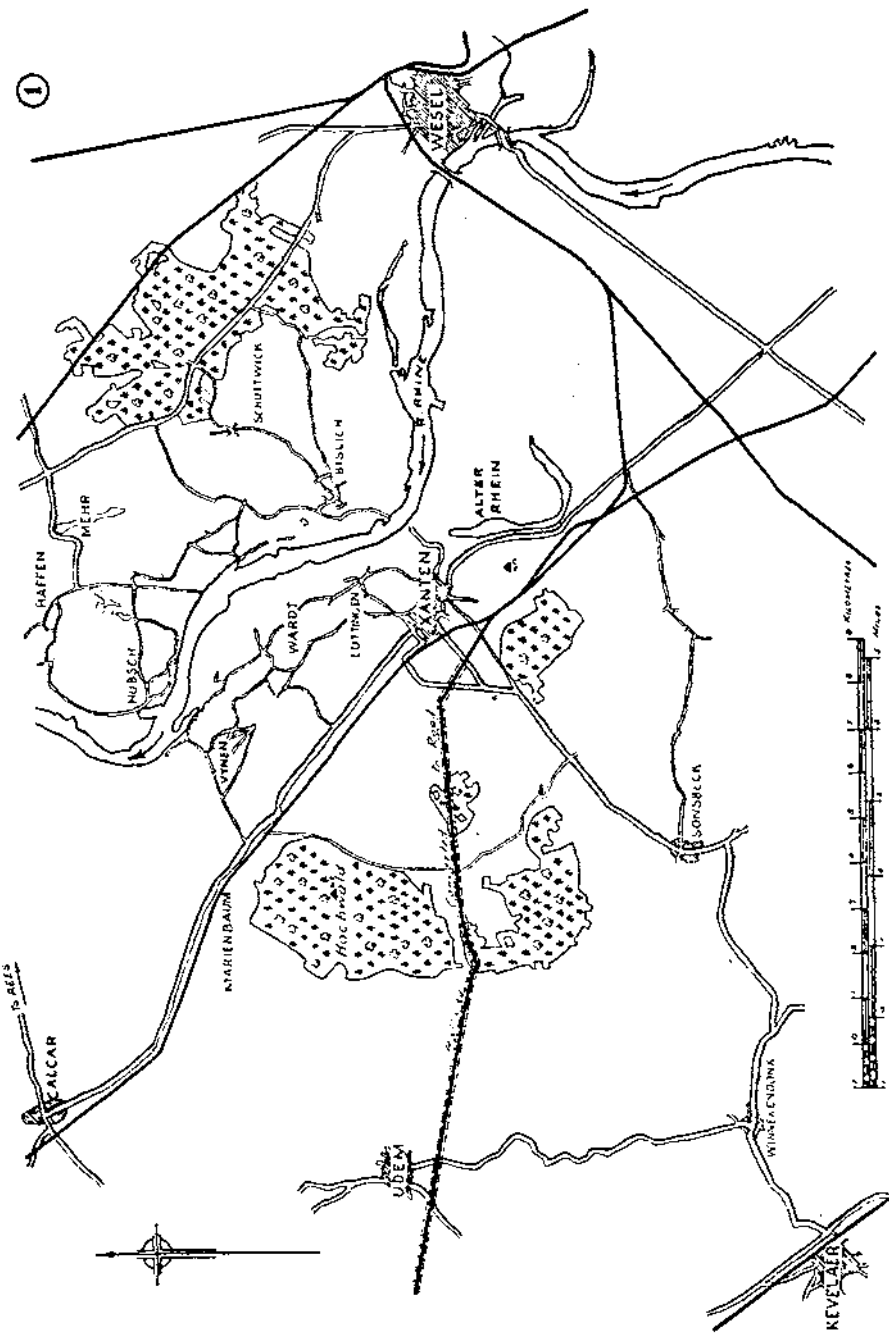
The bed of the river in this northern plain has been built up of sand and gravel by the early meanders and countless changes of course, which through the ages have built up three terraces. The terrace bordering the present river near Xanten is from 20 to 25 metres above sea level, and is composed of a fine and somewhat clayey soil with deposits of gravel and sand.

The area inside the floodbanks has a top layer of muddy silt caused by deposition during flood periods.

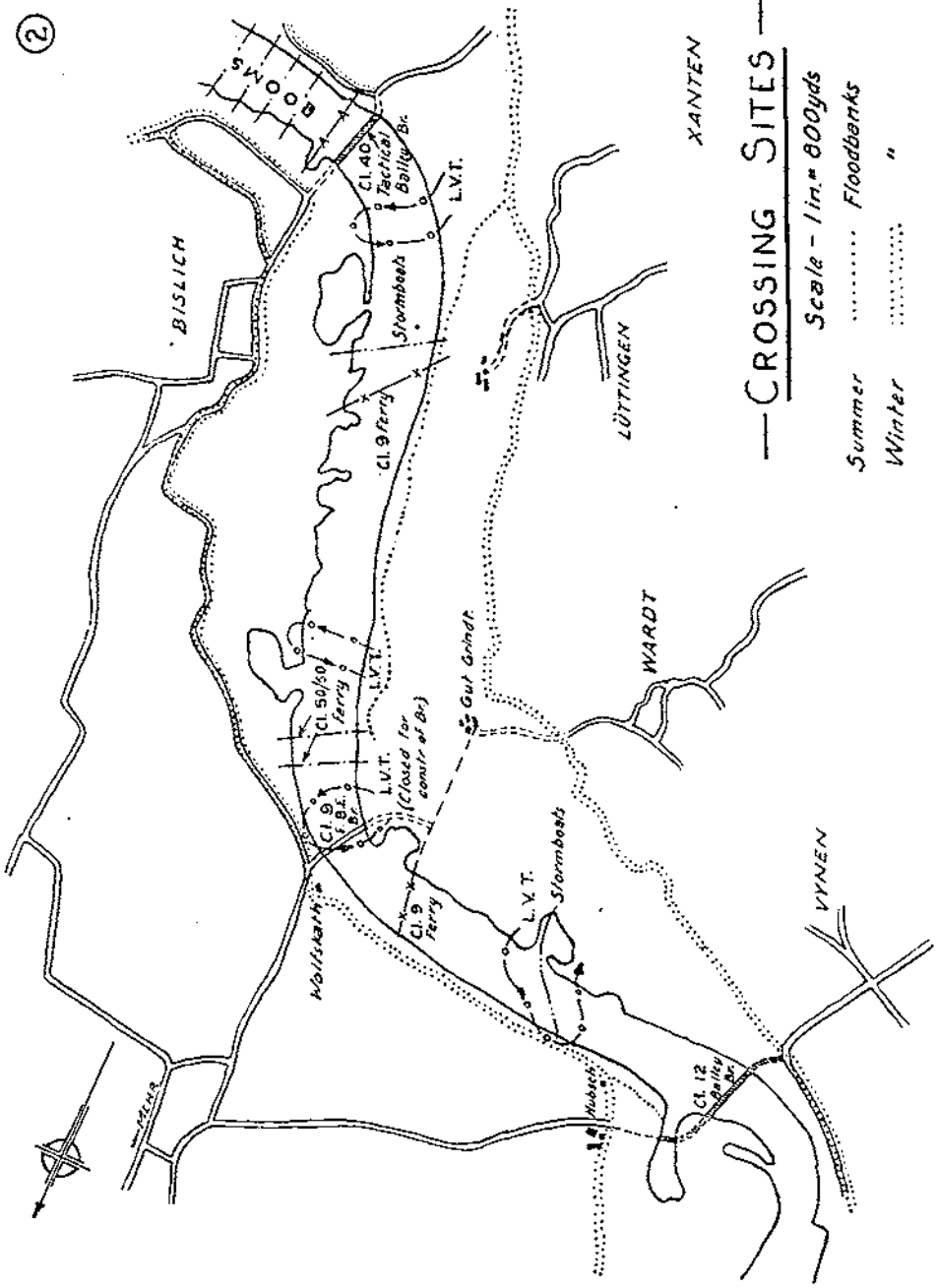
Narrowing this topographical outline down to the operational front, it will be seen from Map 2 that the main flood dyke on the home side cuts the corner from Xanten to Vynen and there is only the comparatively low summer dyke following the course of the river. On the far bank the floodbank stands back from the river near Bislich but gradually swings towards the bank as it goes north until it runs parallel to the river only a few metres from the waters edge. These floodbanks varied in height according to the level of the ground they traversed, but the average height was 12 to 15 feet, occasionally rising to 20 ft. They had a wide base, varying from 50 to 70 ft., from which the faces sloped up to a flat top about 10 ft. wide, the river-ward face always being the less steep. These banks were therefore considerable obstacles to vehicles, though they provided an excellent screen to movement and made it possible to approach to within a few hundred yards of the water in many places.

Further back from the river on the home bank, the ground rose on the

CROSSING THE RHINE



Map 1.


②
SWOOB
BISLICH
Cl. 40 Tactical Bailey Br.
L.V.T.
Stormboats
Cl. 9 Ferry
LÜTTINGEN
XANTEN
Cl. 50/50 Ferry
L.V.T.
Cl. 9 F. Br.
L.V.T. (Closed for const of Br.)
Gut Grindt
WARDT
Cl. 9 Ferry
L.V.T.
Stormboats
WOLFSHEATH
VYNEN
Cl. 12 Bailey Br.
— CROSSING SITES —
Scale - 1 in. = 800 yds
Summer ..... Floodbanks
Winter ..... "

Map 2.

right flank to a wooded feature just south of Xanten and on the left to the Hochwald Forest (see Map 1). Both of these stood, at their highest points, some 150 ft. above the level of the river and, in the case of the Xanten feature, only 2 km. from the far bank. High ground on the enemy side did not begin till some 6 to 7 km. back from the river and then only rose to about 50 ft. above the river. Consequently the advantage of ground both for observation and command lay with the assaulting troops.

Any advantage the enemy might gain from the cover from observation by the floodbanks was neutralized by the unrestricted British air superiority, which at the same time prevented him from seeing what lay beyond the banks on the home side. At the same time numerous small farms and copses, Xanten itself and the villages of Vynen, Wardt and Marienbaum gave additional cover for work and dumping stores.

The road system was based on the Xanten–Marienbaum lateral, a good two-way tarmac road, little damaged by bombing except through the town of Xanten, which had suffered very heavily from air raids during the preceding month. Here also, the roadway was restricted by two arches, one comparatively modern, linking two houses across the street and which was deliberately demolished before the operation, the other the celebrated Mediaeval Cleverstrasse Gateway, which, although it restricted the road to one way at this point was wide enough to let through the largest normal military load and was therefore left intact. Had it been too narrow it would have proved a long and laborious job to demolish and clear back from the roadway. One first class forward route ran from Geldern to Xanten, but otherwise forward routes had to be devised from the existing secondary roads and even by the conversion of a railway. Forward of the lateral, one route only led to the river to the site of the Xanten ferry ; previously the only means of crossing the river, since no bridges existed on this stretch of the Rhine. The ferry exit on the far bank linked up with a network of roads in the village of Bislich and a far bank lateral which ran along the top of the flood dyke. This road from Xanten to Bislich was the only route immediately ready as a bridging or rafting site. In the centre of the front a minor road ran from the lateral to the village of Wardt and then on, deteriorating considerably and extensively cratered where it crossed the floodbank, to the farm of Gut Grindt. From thence to the water's edge a cart track led to a few metres from the water over the usual flood meadow, reasonably hard in dry weather but a bog when wet. On the extreme left flank the third forward road led from Marienbaum to Vynen, some 16 ft. wide with a tarmac surface and beyond Vynen turned into a gravel road which climbed on to the floodbank and turned north, at this place some 200 yds. from the river. Beyond the main lateral, another minor road connected Vynen, Wardt, Lüttingen and Xanten, but this in places was in bad repair.

On the far bank, with the exception of the Bislich ferry road, the roads were very poor and led to nowhere in particular. On the centre and on the left flank however, narrow gravel roads led down near to the river opposite Wardt and Vynen, although they did not provide any good exits for bridge, ferry or "Buffalo" (Landing Vehicle Tracked).

The river itself was on its best behaviour. The level was normal for the time of the year, having just finished dropping from a fairly high flood level caused by early thaw and heavy rain, which augured well for a steady period. The average width was between 1,000 and 1,400 ft. with a current of about 3 knots and this did in fact remain constant until two days after the operation started when heavy rain caused a rise of about 1 metre over four days.

Apart from a little wire and some trench work on the far bank, backed by a few hastily laid mines on the roads and verges, both the river itself and the far bank were clear of man-made snags and air photographs taken up to a few days before the operation showed that no major "beach" defences would have to be tackled.

The supply of Engineer intelligence for planning was excellent. Besides a specially prepared dossier for this section of the river there were available numerous graphs of water levels over a period of years, cross and longitudinal sections of the river, ground reports, observers' reports and an excellent supply of first class air photographs all of which were excellent for briefing the reconnaissance parties which eventually went on to the ground by night and confirmed or rejected the decisions made from map and photograph.

Tactical Background

To follow how the Sapper plan supported the assault a brief description of the tactical background will be necessary.

The Western bank of the Rhine had been cleared of the enemy and was firmly held by our own troops some two weeks prior to the assault.

In outline, the Corps' plan of attack on the Xanten sector was to hold the line of the river with one infantry division and to pass the assault division across on a two brigade front just down stream of Xanten. A third infantry division was held in Corps reserve, whilst an armoured division was to cross as early as possible to exploit success.

Under the direction of the Corps an assault technique had been developed, employing Buffalos (Landing Vehicles Tracked) to carry the leading waves of infantry. Stormboats were to follow with the reserve battalions of the leading brigades and later the battalions of the reserve brigade. Fighting Vehicles of the leading troops were to be ferried over by Buffalo ferries in the case of Class 5 vehicles and below, and Close support rafts were to take over heavier vehicles not exceeding Class 9. A regiment of D.D. (Amphibious) tanks was scheduled to cross at first light to support the infantry. A DUKW (Amphibious Lorry) ferry was also to be provided for medical and initial "Q" build up on the far bank. The provision of the heavy raft ferry and the bridging programme are dealt with in the Sapper plan.

The divisional plan for the assault in order to secure a bridge head was very briefly as follows. The right brigade was to go for Bislich and secure the area Schuttwickloh-Bislich. The left brigade was to secure the area Haffen-Mehr. The reserve brigade was to pass through and secure the high ground Clasenho-Mehro. Subsequently the assault division was to link up with and take over from the Airborne troops.

Zero hour for the assaulting brigades was fixed for 02.00 hrs. 24th March—i.e. the time the leading Buffalos entered the water.

A word now regarding the flanks. On the right an independent commando brigade under command of the same Corps was to assault the Rhine approximately two miles down stream of Wesel to take the town from the flank and rear. Zero hour for this attack was three hours in advance of that for the Xanten division assault. On the left another Corps of Second British Army was carrying out an attack on a similar scale as already described in the area of Rees, with zero hour timed four hours in advance of the Xanten attack. It will, therefore, be seen that whilst it was likely that the Xanten attack lost a certain measure of surprise, the enemy on both flanks were hardly likely to give trouble, since they were well committed some hours before. The division on the Xanten sector also enjoyed the maximum advantage from the airborne attack whose main forces were concentrated on the divisional axis

of advance. The timings for this drop was 10.00 hrs. the same morning, 24th March.

Engineer Plan

Considerable general planning had been carried out by the Engineer Staffs of Second Army and amplified by 12 Corps. The sector of the river had been divided up into likely crossing places for Buffalos, rafts and bridge sites after due consideration had been given to approaches, nature of banks, depth of the river, etc.

It was appreciated that heavy rain, floods or a spate in the river would make the operation almost impossible. It was, therefore, laid down that the operation would only take place if the river was flowing in its normal channels with a current of three to four knots, if the flood plain and flood bed could be traversed by fully tracked vehicles, and the weather forecast for the first seven days of the operation was favourable.

The Sappers were to produce 40 stormboats and ferries consisting of four Class 9 rafts with two spare on each brigade front. On the Divisional front, they were to produce a tank ferry of four Class 50/60 rafts with two spare rafts, a Class 9 Folding Boat bridge, a Class 12 Bailey Pontoon bridge, a Class 40 Bailey Pontoon bridge, and ferry "hards" for D.D. tanks and DUKWS. Good approach routes, up to the class of each crossing, were to be provided for all but the tank ferry site. A total of twelve heavy tugs were to be launched for river defence of the bridges against swimmers, floating mines or explosive craft. Boom protection on a lavish scale was to be provided to protect the bridges against floating mines and debris. In addition, approach routes across country were to be made suitable for Buffalos and D.D. tanks from their forward assembly areas to the river's edge and exits from the river to the hinterland on the enemy side. Normal mine clearance and repair of routes were to be effected on both banks of the river. As soon as possible after the initial assault an all weather Class 40 Bailey Pontoon bridge to cope with a rise of 6·2 metres (nearly 20 ft.) in the river was to be constructed.

Considerable preparatory work was required on routes west of the river so that the vast number of armoured and soft vehicles could move smoothly by night into their appointed assembly areas. Arrangements had also to be made to maintain these routes in all weathers under the heavy flow of traffic to be expected when the bridges were open. A large dump of several thousands of tons of Engineer stores and equipment had to be set up. During the planning period the proposed site of this dump had not been captured and the Canadians were fighting a bloody battle for its possession.

To carry out these tasks, an A.G.R.E. H.Q. was to be put under command of the Assaulting Division, the Commander of the A.G.R.E. to be responsible for the detailed planning of the crossing and to command all engineer troops engaged on the crossing. As the assaulting division moved over the river the A.G.R.E. was to revert to command of the Corps, having freed the engineer troops of the assaulting division to continue in their normal role. The Commander A.G.R.E. was responsible for all R.E. tasks forward of an agreed divisional rear boundary on the west bank up to the nearest lateral road on the east bank.

The R.E. commitment for the Corps crossing on a one divisional front worked out at the astonishing total of twenty-nine field companies. These were to be employed as follows:—five field companies with each assaulting brigade for the operation of stormboats, construction and operation of the Class 9 Close support ferries and the construction and maintenance, including mine clearance, of approach and exit routes; three field companies

for the construction of the Class 9 Folding Boat bridge, including approaches, whilst the Class 12 and 40 Bailey bridges absorbed a further four field companies each. The Tank raft ferry accounted for three engineer assault squadrons and the construction of the booms one more field company. The maintenance of routes forward of the divisional rear boundary swallowed up a further three field companies, leaving a balance of one field company as an engineer reserve out of the total of twenty nine.

The Chief Engineer of the Corps undertook to stock and man the R.E. dump and a Bridge Company R.A.S.C. was put under command of the A.G.R.E.

A C.R.E. was appointed in charge of each of the assault crossings, to work in support of the assaulting brigades. One C.R.E. was responsible for each bridge, and a C.R.E. of the Assault R.E., who had specialized in heavy rafting, was responsible for Heavy Tank rafts. The C.R.E. of the Division holding the line of the river was made responsible for the completion of all the preparatory work prior to D-Day and the maintenance of routes.

The O.C. field company engaged on the construction of booms, assisted by a R.N. Boom party, worked directly under the A.G.R.E.

K Squadron, U Force R.N., was divided between the two Cs.R.E. on the Bailey bridges for launching and operating the Heavy Tugs.

The C.R.E. of the assaulting division was to be left free to plan the work required forward of the first lateral on the enemy bank. Two of his field companies were put under command of the Cs.R.E. assault crossings, to do the minimum work necessary to provide routes passable for infantry and vehicles ex the Class 9 ferries and Stormboats, on completion of which they reverted to his command.

This was the framework of the R.E. plan. What now remained, was to collect formations experienced in the particular types of work envisaged and to train them with the assaulting troops. They had then to be moved up to forward assembly areas, from which they could jump off to their tasks.

Training

Since many of the engineer formations to be used in the operation were heavily engaged in route maintenance for the previous operation or in the bridging of the River Maas at Venlo—major engineer operations in themselves —the time available for training the sappers was limited. By careful allotment of tasks by the Chief Engineer of Second Army, formations were just released in time to carry out essential training with the assault division on the River Maas upstream of Maesyck.

Of the field companies to operate stormboats and Class 9 rafts, one formation was expert, and the other rather inexperienced. The inexperienced formation was given extra training and brought up to a good standard.

Drivers of all infantry and gunner vehicles were practised in driving on and off Class 9 rafts. Infantry battalions were issued with stormboats and practised loading personnel.

The River Maas produced some misgivings, since at one period a flood current with a wind downstream made the Class 9 rafts almost unmanageable, and it was thought that cables would be necessary to operate the rafts, Tests were accordingly carried out on the River Waal at Nijmegen in getting cables over a river 1,400 ft. wide and operating rafts on them.

Two exercises were carried out with the assaulting brigades crossing the River Maas. One of these was in daylight, the other by night, with searchlights providing artificial moonlight and Bofors guns firing tracer shell to give flank direction.

On the exercises, Buffaloes out of control broke the raft cables and an impasse appeared to have been reached. Fortunately the standard of watermanship of the Sappers increased so well that the necessity for use of cables was obviated. Tanks practised over heavy tank rafts in both exercises. It was impossible to produce both the mass of transport and the number of R.E. formations, which would be taking part in the final crossing, so that, except for the assault crossing, all Sapper units were in token on the exercises. Thus, the R.E. communications, which were to be improvised, could not be practised, nor were the problems of movement of vehicles fully demonstrated.

The Boom company practised construction of the American type of arrow-headed booms, in addition to the normal floated steel wire cable.

Corps Signals practised laying a weighted cable from stormboats.

A Lieut.-Commander, R.N. arrived with a special mobile crane and L.C.V.(P)s (Landing Craft) mounted on trailers. Methods were practised for launching these landing craft from their trailers over all types of banks either by crane or by tipping them off cradles from the trailers and then pushing them with bulldozers into the water.

It was found that loaded Buffaloes could not surmount the normal floodbank with side slopes of 1 in 1 to 1 in 3. This produced another complication, since twelve gaps in each floodbank would be required in the final operation. Experiments were tried with crater charges and line charges—of explosives and also with bulldozers to find the best method of cutting the gaps through the floodbanks.

Reconnaissance

A fortnight before the operation was due, all commanders of R.E. formations met together, were briefed in their tasks and reconnaissances were ordered. They had to liaise with the Holding Division for river bank and all forward reconnaissances, which were done by night, but reconnaissances of routes, forward assembly areas, stormboat and Class 9 raft "hides" and forward H.Q.s could be done by day, since the river bank was smoked for long periods each day over a huge front. R.E. officers went up with all route reconnaissances to see what work was required on Buffalo routes, D.D. tank routes and marching infantry routes. The gallant Lieut.-Commander, R.N., with the C.R.E. due to build the Class 40 Bailey bridge, went down to the bridge site by night, calmly stripped and swam about in the water to test the depth for his landing craft. Fortunately the enemy did not spot them. Two field company commanders of the right crossing formation were wounded by mortar fire, but these were the only casualties on reconnaissance.

Reports came in of craters in the roads forward of the floodbanks, where work could not be carried out before the start of the operation. The bridges on the main up route from Sonsbeck to Xanten had to be doubled and a railway converted to a track fit for vehicles with several turn-offs at junctions with roads.

Movement Plan

It was appreciated that the movement of engineer troops, stores and bridging equipment would present a somewhat complex problem and much thought and work had been put into its detailed organization. The problem involved two phases, firstly to move all troops and stores to forward concentration or assembly areas and subsequently to move forward to sites of work on the river.

The division of responsibility for movement was that the Chief Engineer of the Corps was responsible for stocking a corps dump at Kevelear with all

bridging equipment and stores required for the operation, whilst the Commander A.G.R.E. was responsible for movement of all troops in both phases and for the movement of all stores and bridging equipment forward from the dump at Kevelear (See Map 1).

In the case of the Cs.R.E. with each of the assaulting brigades it was decided to marry the troops with their equipment and move them a distance of approximately 70 miles to their forward concentration areas just S.W. of the Hochwald Forest on D—5. This arrangement permitted the predumping in forward hides to proceed during the three nights preceding the assault. Owing to the distance and the congestion on the routes it was considered impracticable to ferry, as the troops were engaged to the last minute in checking, repairing and marking the stormboats and rafts (the majority of which had been used on training). This decision involved an allotment of 60 three-ton lorries to each C.R.E. from R.A.S.C. resources, even so, this number would only permit of non-tactical loading, i.e. three stormboats per lorry. For the moves down to the hides, however, tactical loading, i.e. one stormboat per lorry was essential. Hence the entire lift of 120 R.A.S.C. lorries had to be regarded as written off for other purposes until the morning of D—1. This fact, though accepted, was looked upon with the utmost gloom by the Chief Engineer and his staff, who were desperately short of transport for their task of stocking the corps dump at Kevelear.

The move of the engineer troops engaged in bridging and boom tasks, approximately twelve field companies in all, with three Cs.R.E. H.Q.s presented no real difficulties. The forward concentration areas allotted were just N.W. and W. of Kevelear. Normal movement orders were issued and units were permitted full scale transport for this move. By last light on D—2 all had reported safe arrival and thus had twenty four hours for rest and final preparations.

For the move forward to the river, transport of all R.E. units had necessarily to be restricted. Each field company was permitted to retain a total of ten vehicles as "F" echelon transport, whilst Cs.R.E. H.Q.s were restricted to six vehicles. The remainder of the transport used for getting the troops forward was returned immediately to rest areas.

The move forward of the troops was organized as follows. The field companies engaged on the bridge tasks, less the Cs.R.E. "O" Groups, were assembled in their respective forward concentration areas in one column—each column was allotted a code word, Routes were laid down and signed with the column code word. The C.R.E. was on site and in touch with the leading infantry brigades. As soon as he considered conditions were likely to permit work commencing he was to make a bid e.g. "Tom" column required in 30 minutes. Road space was confirmed with tactical division by A.G.R.E. and word passed to the C.R.E. to move off the column. The C.R.E. was in touch with the column by wireless, line and/or D.R. In all cases the system worked well, with the outstanding advantage of keeping the bulk of the engineer troops well back, resting until they were actually required for work.

The final phase was the move forward of engineer stores, plant and bridging equipment. Again much thought had been given to this, and the detailed organization so ably carried out by the bridge company commander and the officer commanding the stores dump at Kevelear paid a handsome dividend in the saving of time.

Each C.R.E. had carefully laid down the order of march in which he wanted the stores, plant and equipment to arrive on site. Each bridging task column was allotted a code letter and the two hundred to two hundred and fifty 3-ton loads required for each bridge were broken down to serials of not

more than sixty vehicles each. It was just possible to have the first two serials for each bridge actually loaded on wheels at zero hour. Hence before the third serial for each bridge could be loaded the first serial would have to have been delivered and the vehicles returned to the dump. The forward routes to each bridge were signed with the column code-word—turn-round had been arranged at the bridge marshalling harbours and the routes for the returning empty vehicles also signed. D.R.'s from the Cs.R.E. were responsible for guiding the columns forward, whilst D.R.'s from the bridge company guided the empty vehicles to the dump for reloading. These were got back in blocks of ten as they were off-loaded in order to waste no time in reloading.

The O.C. Bridge Company was made responsible for marshalling each serial in its detailed order of march, assisted by L.O.'s from each C.R.E. Hence it was possible to marshal standard bridge company units, lorries loaded with specific R.E. stores, and transporters carrying plant in any particular column. The co-operation between R.E. and R.A.S.C. was excellent and the results obtained speak far better than any written words of praise.

The procedure for movement of bridging differed slightly from movement of the troops. The C.R.E. on site was to initiate the move, by giving an estimated time he would require any particular serial of his column on site in accordance with the conditions existing. A.G.R.E. Tac. H.Q. in conjunction with the Tac. H.Q. of Division confirmed that road space was available and that everyone concerned was duly warned that a bridge column was coming through. H.Q. A.G.R.E. then informed the bridge company to move off the specified serial at a given time e.g., " Digger " " A " 04.30 hrs.—the time being the time the column crossed the start line. H.Q. A.G.R.E. then informed the C.R.E. the estimated time of arrival of the column.

The organization worked admirably and so well did the bridge company and dump staff do their job that all turn round serials, i.e. reloaded from returning empty vehicles, were loaded and ready to move off again long before they were required. The total vehicle loads for the three bridges involved was something of the order of one thousand 3-ton loads. All these were delivered on site by zero + 24 hrs., thus proving that the planning and organization had been sound.

Preparatory Work

The Engineers of the Holding Division assisted by the Corps troops carried out all the preparatory work, which was a heavy task.

Mines had to be cleared from the Hochwald forest. The old Hun ammunition dump near Xanten contained a number of fused aircraft bombs, some of them booby trapped. Parties neutralizing them were occasionally mortared. Buffalo routes, where they crossed streams had to be culverted and the berms of roads strengthened to prevent the vehicles destroying the vital roads in crossing. The approach route from Wardt to the Class 9 bridge site was cratered where it crossed the floodbank and these craters were surreptitiously filled in during the two last nights, without altering the contours of the damaged floodbank. A large dump of approach materials was stocked up well forward, in case the weather turned bad. Considerable work was done in Xanten to open up roads which had been blocked by bombing. The Commander of the A.G.R.E. kept in touch with and directed these preparations by flying up to the area on more than one occasion, since the roads were full of vehicles moving up to concentrate.

Eighty stormboats each with a sledge and sixty sledge loads of Class 9 raft equipment had to be dumped in selected hides behind the floodbanks

prior to the operation. This was effected in the three nights before D—1/D night and the precious loads camouflaged as dumps of straw, chicken houses, etc. Thumbs were held lest these be discovered by the Hun jet reconnaissance planes. The sapper operator of each outboard engine went with it and lived with it near the "hide." On D—1/D night a total of 50 White half-track vehicles were moved to the hides and hitched on to the sledges to tow the stormboats and Class 9 rafts about six hundred yards to the river's edge under cover of the noise of the artillery barrage. In case these stuck, a total of 980 men of the Holding Division stood by to carry the boats. Each boat is a heavy load for twenty men—its engine a good 4-man load. In addition, twelve bulldozers reached their appointed places to cut through the floodbanks without discovery and all that could be done before zero hour was now ready.

A most complete layout of signal cable had been laid from Tac. Divisional H.Q. to connect the tactical A.G.R.E. H.Q. with the forward tactical H.Q.s of each C.R.E. and then on to bridge sites, and raft sites. From the R.E. exchange, it was planned that the Commander A.G.R.E. could communicate by phone with all his R.E. formations, the Chief Engineer of the Corps, the R.E. dump and the Bridge Coy. with a connexion through the Divisional exchange to all infantry formations. To minimize the chances of damage to cable by shell-fire all cables had been ploughed in.

Final Preparations

On Friday, 23rd March, the Divisional Commander held a final short conference at 10.00 hrs. to check that all was ready. It was to be confirmed at 16.00 hrs. at Div. H.Q. by codeword that the operation was on. Conditions looked perfect. The ground was *firm*, dust swirling up from the country roads as vehicles moved on them. An early summer sun shone in the sky. The decision, however, did not depend entirely upon local conditions. Flying conditions by night must be suitable in many airfields in Britain and France for the Air Armada to take off ; conditions must be suitable for parachutists and gliders on the east bank of the Rhine. In the afternoon Tac. H.Q. of the Division with Tac. H.Q. of the A.G.R.E. moved to a little farm just off the Xanten-Marienbaum lateral where the H.Q. of the Bank Group was set up. The Bank Group was a traffic control organization to regulate all movement of vehicles and personnel. Here in a barn an R.E. intelligence office was improvised, lined communications to such formations as were in position were tested and all ranks dug in busily. Since wireless silence had been imposed there was no means of ensuring that the thirteen outstations of an improvised net would come up at zero—3 hrs. correctly, but the Signal officer, who had been lent by the Holding Division Reconnaissance Regiment personally visited all the outstations and checked their wave-metre netting. By nightfall the Cs.R.E. of each crossing had reported themselves and their troops in position ready to commence cutting the floodbanks and moving down to the water's edge.

At zero—5 hrs. all the guns opened up, at first supporting the attack of the Division on our left. The bulldozers commenced work on the floodbanks and by zero—3 hrs. all gaps were ready for Buffaloes and for the passage of towing vehicles and sledges. All stations on the R.E. net came up at strength 5 and by zero hour the C.R.E. left crossing reported all stormboats and two rafts in the water (this was ahead of schedule) and the C.R.E. right crossing reported that he was up to timetable with half his stormboats in the water.

The Battle from Zero Hour—(See Map 2)

So many independent actions were taking place at the same time that a chronological description covering the divisional front would be confusing. It will be clearer to follow the action of each R.E. formation to its conclusion.

C.R.E. Right Crossing

The Field Company responsible for work on the enemy bank was loaded in Buffaloes with the leading infantry and made the eerie crossing of the river at zero hour. They found a number of Schu mines and came under fire from small arms. The O.C. was hit in the thigh but continued with his men until ordered back at about 10.00 hrs. Captured Huns were turned on to show where the mines were laid. By 02.45 hrs. twenty-four stormboats were in the water, and a quarter of an hour later equipment for four rafts was towed out of the "hides." The raft equipment reached the water at 03.30 hrs. and by 06.30 hrs. two rafts were completed and operating, the other two having been smashed by enemy gunfire which caused some casualties. A reserve raft was brought up and was operating by 10.30 hrs. and later a fourth was made up. A cheery 'phone message that two hundred prisoners were working well on putting down track material for the approaches told H.Q. that all was going well. An unsolicited testimonial was received from a passenger, who congratulated the raft crew on their watermanship on one of the return trips. He was a German officer.

The stormboats had taken the reserve battalion of the assaulting brigade over by 04.00 hrs. and a battalion of the reserve brigade by 06.30 hrs. The Class 9 rafts worked continuously for 2½ days and nights transporting 611 vehicles forward and bringing back casualties and prisoners of war. The formation was then taken off to start the major operation of constructing the Class 40 flood proof Bailey Pontoon Bridge of which they made a magnificent job.

C.R.E. Left Crossing

As in the right crossing the far bank Field Company crossed in Buffaloes but their reconnaissance party ran into enemy infantry and all but one become casualties. The stormboats had a bad start. They were not used immediately, since resistance had been met by the initial assault, and the far bank opposite was not cleared. As dawn broke they were heavily engaged and had to roar off downstream running the gauntlet to a more sheltered spot, led by their O.C. who was suffering from a bullet wound in his jaw. He insisted on working for the full day and though casualties had been heavy, his stormboats transported the reserve battalion, reserve brigade and 1½ Field Companies forward during 24th March, bringing back 19 loads of prisoners, 14 loads of British casualties and 12 loads of enemy casualties. The first raft was completed by 03.15 hrs. but the enemy were sniping as the light permitted. By 05.00 hrs. two rafts were completed, but heavy mortar and machine gun fire stopped work until 09.00 hrs., by which time three pontoons had been damaged and a number of casualties sustained. Rafting proper commenced at mid-day and continued for two days and nights though there were slack periods due to the opening of the Class 9 Bridge. About 440 vehicles were transported during this time.

Airborne Drop

It may here be mentioned that at 10.00 hrs. there was a sudden cessation of the appalling din of gunfire which had been continuous for thirteen hours and the magnificent spectacle of the Airborne Corps sailing in relentlessly

to their task cheered the troops engaged in the assault. The enemy gunfire slowly died as our airborne troops silenced their batteries and the crossing continued in comparative ease.

Heavy Tank Rafts

These were concentrated in two columns, one south of the Hochwald forest and one in the old ammunition dump on the wooded hill south of Xanten. Each column consisted of 28 tanks, each towing a sledge or a trailer. Their move to the village of Wardt and thence to the river crossed or used some of the approach routes for fighting vehicles and bridging vehicles and had to be carefully timed so as not to delay movement to the ferry and bridge sites. The large pontoons on trailers were a good target and could not be risked until enemy observation had been dislocated. The site chosen for rafting was between the two brigade initial bridgeheads and the far bank was not cleared until 11.00 hrs. The advance party for approach work tried to move out of Wardt at 07.00 hrs. but was held up by mortar and 88mm. fire. The C.R.E. managed to do a reconnaissance between 11.00 hrs. and 13.00. by which time he was able to start work on the approaches. For the far bank he had loaded three airborne-type bulldozers in Buffaloes and put them in charge of his A.P.T.C. Sjt. as guide. Arrived on the far bank, this serjeant led his three little mechanical vehicles towards their appointed site, when they were engaged by some enemy infantry. Raising their blades like angry crabs the baby bulldozers advanced on the enemy directed by the P.T. Sjt., who came out victor of this unusual battle and led his prisoners back. The first raft equipment arrived at 14.00 hrs. and was operating in six hours, followed half an hour later by two more rafts. All these worked on mechanical winches. Later a fourth raft was constructed. In the first thirty hours, 191 tanks were ferried across, the total coming up to over three hundred before the Class 40 Bridge claimed all such loads.

Class 9 Folding Boat Bridge at Wardt

The site for the Class 9 bridge was chosen with the least suitable approaches of the three, since the value of the bridge was in its quick construction to take the first rush of light vehicles. Also it was easier to make up the approaches for light traffic than for heavy. It was to be a very temporary bridge. The C.R.E. called for his bridging vehicles at 06.00 hrs. One serial of sixty vehicles was sent down but could not advance from Wardt owing to heavy enemy fire. The first vehicle reached the river at 13.00 hrs. and from then on bridging and construction of 1,000 yds of approaches continued uninterrupted. In ten hours the bridge, 1,320 ft. of it, and the approaches were complete—a fine performance. Traffic flowed immediately but the exit roads were not all cleared of the enemy and diversion of traffic on the far bank was necessary. This caused delays and in the dark at 02.00 hrs. on the 25th March a jam of traffic at one end of the bridge broke it, twenty-two bays were half sunk and displaced downstream. The re-construction was more difficult than the original construction, but the bridge was reopened by 13.00 hrs. on 25th March.

Class 12 Bailey Pontoon Bridge at Vynen

This was to be established from Vynen on to the spit of land opposite and then by a second bridge to connect with the track leading to Hubsch (See Map 2). Owing to the enemy resistance in Rees, downstream, Vynen was subjected to considerable shell and mortar fire. The C.R.E. with his advance party were enforced troglodytes in cellars for some hours, but at

14.15 hrs. the first bridging vehicles were able to get to the site. Three heavy tugs (Landing Craft) were successfully launched. It was refreshing in the middle of the battle to see unconcerned sailors in their white caps sitting upright in their large craft, balanced on transporters and slowly rumbling down the main lateral from Xanten to Marienbaum. Several difficulties arose. A bulldozer blew up on a mine in the main approach, two steel wire cables parted in midstream, and a whole raft broke away from its towing tug and damaged some pontoons. Sandbanks and awkward currents appeared near the spit. The two lengths of bridge were completed in forty-three hours work—a total of 1,940 ft. of bridge—and traffic was flowing by 08.00 hrs. on the 26th March.

Class 40 Bailey Pontoon Bridge at Xanten

The site for this bridge was just downstream of the old ferry stage at Xanten. The approach road was cratered near the river, but the C.R.E. took a chance and filled the crater by preloaded tip-trucks during the barrage before zero hour. By 09.30 hrs. the first bridging vehicles were at the site and were being unloaded, while the detailed reconnaissance was made and centre line laid out. Four landing craft were launched by crane off the old jetty by 14.00 hrs. Despite some damage and casualties caused by enemy shellfire, the bridge was completed in thirty-one hours, being 1,102 ft. long and involving the use of 750 tons of equipment. This was the first Class 40 bridge across the river Rhine on the Second Army front.

In addition to the bridge construction, ferry hards for DUKWS were completed by 15.00 hrs. on the 24th March and were used until the bridge was opened.

Booms

The Field Company constructing booms commenced work upstream of the Class 40 bridge site at Xanten at 14.00 hrs. and by midnight they had nearly completed two of the arrow-type booms. There was a scarcity of steel wire cables of sufficient lengths to span the Rhine and spliced cables proved unsatisfactory. A total of five booms were completed after many difficulties and served good purpose, since several explosions occurred on them by night. It was never discovered what type of floating mines they had detonated.

The floodproof Class 40 Bailey bridge was later completed to a total of 2,080 ft. in 144 hours and acted as a duplicate for the original Class 40 bridge at Xanten.

Conclusion

Thus concluded the Battle of the Rhine. The forward troops were swarming into the heart of Germany. Rattling over the bridges went the follow-up and build-up divisions to press on to final victory. The engineer formations were pushed forward to their multifarious tasks with the advancing army, leaving a bare minimum to maintain their bridges, collect and dispatch forward rafting and bridging equipment, rebuild the floodbanks and generally tidy up the scene of the biggest river crossing operation of North-West Europe. There were some formidable rivers ahead.

Though favoured with the advantages of perfect weather, air superiority and overwhelming fire support this operation, fraught with so many potential hazards, earned if any operation did, the right to be reported as having gone " according to plan."

INSPECTION

By Maj.-Gen. A. W. Sproull, C.B.E., A.C.G.I., B.Sc.(Eng.), M.I.Mech.E., M.I.E.E.

(Extracts from the Presidential Address delivered before the Junior Institution of Engineers on 13th December, 1946)

I OFFER you my sincerest thanks for the honour you have done me in electing me to be the fifty-ninth President of the Institution, and I hope I may be further honoured by being elected as an ordinary member of your Institution on completion of my Presidency.

I think I can assume that your invitation mainly arose from the interest alive in your members in one of the engineering aspects of supply—that covered by the much embracing term "Inspection."

I have the honour to have graduated in the Corps of Royal Engineers for the past thirty-two years, and, in common with other members of the Services, have suffered from, and occasionally rejoiced in, all sorts of inspections.

These basically were intended, although sometimes reminiscent of Colonel Blimp and his ways, to keep us up to the mark, and they usually succeeded in doing so, and although inspections of the Services type with that particular end in view might be beneficial in very many works, I do not propose to devote my address to this form of inspection.

Before the war, one of my main official pre-occupations was inspection of Service equipment, and during most of the war I was responsible for the inspection of engineer, telecommunication, and radar equipment, and mechanical transport vehicles. This theme is the subject of my address.

Inspection is coeval with manufacture. My authority for this statement is in the first chapter of Genesis. Archaeology also reveals to us that throughout the ages the worker in clay, stone, bronze and iron has carefully surveyed the work of his hands to ensure the utensils he had made were to his own satisfaction. We may ask "why?" but the answer is not far to seek. Human nature is imbued with the spirit of criticism. In this connexion, of course, the word "criticism" must be understood in its constructive sense—the pronouncement of a scientific judgment beneficial to its recipient; the other variety, besides being a weariness to the listener, is quite valueless for practical purposes. No critic, worthy of the name, should disparage another's efforts; he should proffer sage counsel in the hope that improvement may result from the course of action suggested.

Some unkind person once defined the critic as "the man who has failed." I suggest that this definition is incorrect. The critical faculty implies the possession of a high standard, possibly even an ideal one, and the type of mind which produces the critic differs from that which gives rise to the craftsman. Both are essential if the acme of perfection is to be reached. Inspection, therefore, is complementary, not antagonistic, to manufacture and should be regarded in the light of "an exposition of intelligent criticism for the purpose of securing the highest quality in output."

We, as a race, are peculiarly prone to criticize. For this reason the custom of carrying out inspection, and inspection of a high order, has always played a prominent part in our national life.

In the old Guilds of the thirteenth and fourteenth centuries, members were bound together under a strict code of rules which did not allow any bad or makeshift work to be executed. The Guilds appointed searchers, who carefully looked over every piece of work produced. The dictum of each craft was the same: "Producers must be protected against unfair competition and purchasers must be assured that the goods they bought were up to standard."

A boy desirous of learning a trade became apprenticed to a master in the craft for seven years; after which he reached the status of "journeyman," i.e., he could be hired by the day or "journée," hence the name. The ambition of a journeyman was naturally to set up on his own. In order to do this he had to submit a sample of his work to the wardens of his Guild, who subjected it to a severe inspection. If his work was accepted it was known as his "masterpiece" and henceforth he was recognized as a master in that particular craft.

This denoted a sound system of inspection.

Turning to the manufacture of munitions, John Judde was appointed Master of Ordnance on the 21st December, 1456, and in his commission he was charged especially with inspection as well as the provision of war material of all descriptions. The Crown mark on all arms was instituted by Charles I in 1627.

In 1543 the Surveyor of the Board of Ordnance was responsible for the inspection of Government stores. By the warrant of the Board, as reconstituted by Charles II in 1683, contracts for arms were made under the sanction of the Clerk of Ordnance, as the financial officer directly responsible to Parliament for estimates and expenditure. The examination of supplies rested with the other parliamentary officer, the Surveyor. It was his duty to prove them and, if good and serviceable, to mark them with the Crown mark. The storekeeper, the custodian of the Board, was prohibited from receiving anything into store except upon the Surveyor's certificate. In this manner the Ordnance system guaranteed the public against frauds in contracts by making the Clerk responsible for price, the Surveyor for quality and the storekeeper for receipt.

Inspection can be defined as the art of securing serviceability by reducing the risk of possible failure in the product inspected, but the technique must vary to achieve the result according to the class of article examined and the degree of quality and performance required.

Inspection is, therefore, an "art" that should be studied from the point of view of scope, aspect, system, type and method, so as to obtain a serviceable article with the minimum expenditure of labour and wastage.

Serviceable, from the Army viewpoint, must be taken in its widest sense and must embrace both interchangeability and functional qualities.

With the ever-increasing mass production and the higher stressing of materials that has taken and is taking place in industry, inspection is becoming more and more important.

In the early days, when only a few equipments were produced it was not generally considered necessary that parts should be interchangeable. It was an accepted fact that during assembly a very considerable amount of fitting had to be done, and similarly with spare parts.

The Services perhaps were the only exception, as it was necessary for parts to be interchangeable with the very minimum of fitting, and

it was obvious that the ammunition must fit the gun. This entailed a higher standard of manufacture and inspection than the normal commercial one.

Also in the old days a complete plant was manufactured generally in one works and there were very little bought-out finished parts. At the present time of specialized production more and more parts and units are bought out. Further, in this commercial age when competition in price-cutting is the order of the day, mass production of articles in common use is the best method of ensuring a high return on capital, and for mass production to succeed complete interchangeability and consequent heavy inspection charges must be accepted.

As a typical case, the motor vehicle is an assembly of hundreds of parts drawn from a common stock rapidly put together with no fitting or rectification of the parts done on the assembly line. Under such circumstances there must be interchangeability unless the firm wish to go out of business. This method of production allows for a complete range of interchangeable spares to be distributed over repair shops and garages at home and abroad. This, in itself, increases the value of the vehicle to the public, and a prospective buyer will obviously take into account when purchasing a vehicle or other machine the facilities for quickly obtaining interchangeable replacements for parts worn out or damaged.

Without a thorough system of inspection, therefore, a business which set out to capture the market would, under modern conditions, fail. The majority of large firms have had for many years a competent and well-equipped Inspection Department, and firms who previously did little or no inspection during manufacture have found, during recent years, that an inspection staff was necessary and, in fact, saved its keep.

At one time, I am sorry to say, there existed in works between the worker and inspector an atmosphere of the poacher-gamekeeper type. This happily is nearly extinct, as it has been realized that both are equally necessary to obtain an article that is satisfactory and produced with the minimum of scrap and waste of labour.

So far we have only considered inspection from the producers' viewpoint, which must inspect and check production at various stages of manufacture in order to ensure a minimum amount of final rejection with its consequential waste of labour and materials. I have personally seen many cases where, through lack of inspection, completed articles have been offered for inspection which were defective at early stages of manufacture.

There is, however, the other aspect of inspection, far more important from the Service point of view, namely, to ensure that we are getting something that will not let us down, and, in fact, inspection is a safeguard of military success and of lives.

It is almost a truism to state that such an inspection must be carried out by a body entirely independent of manufacture not only technically. but financially. This principle, however, was not recognized by the War Department till the late eighties. In 1887 a committee, presided over by the Earl of Morley, was set up to inquire into the organization and administration of the manufacturing departments of the Army. One of its recommendations was :—

> "An Inspector-General of Warlike Stores should be appointed who should report direct to the Surveyor-General of Ordnance, all weapons of war and stores supplied to the Army from Government factories or from the trade should be inspected, listed, and passed under his direction and on his responsibility."

This policy was adopted and the Inspection Department came into being on the 1st April, 1888, since which date the inspection of stores for Army purposes has been absolutely divorced from manufacture, both as regards supplies from Government sources and from the trade.

By these few historical remarks I hope that I have shown that the practice of inspection is a rational process of long standing and not some new-fangled terror imposed on industry by Government Departments to distract and harry manufacturers.

The Ministry of Supply, as you are aware, is responsible for the provision and inspection of all stores and equipment for the Army. The inspectorates during the latter part of the war were :—

Inspector-General of Armaments: Responsible for the inspection of all armament stores, which included guns, carriages, rifles, mortars, machine guns, pistols, bayonets, ammunition and explosives, anti-gas apparatus, fire-control instruments, flame-throwers and chemical warfare equipment.

Director of Fighting Vehicles Inspection: Responsible for the inspection of tanks and armoured cars.

Chief Inspector, Electrical and Mechanical Equipment: Responsible for the inspection of all engineer, telecommunication, radar stores and equipment, and also mechanical transport vehicles, trailers and bicycles for all Services.

Chief Chemical Inspector: Responsible for the inspection of all chemicals, plastics, oils, rubber, paints, varnishes, preservations, packing materials, and explosives in bulk, chemical warfare materials, and general chemical service to all inspectorates.

Chief Inspector of Stores: Responsible for the inspection of general stores.

Chief Inspector of Clothing: Responsible for the inspection of Army clothing and boots.

I am not competent, nor have I the time, to deal with all these inspectorates and will therefore confine my remarks to C.I.E.M.E., whose title, prior to the 28th September, 1942, was Chief Inspector, Engineer and Signal Stores. The name was changed when the inspection of mechanical transport vehicles and trailers for all Services was transferred from the Chief Inspector, Mechanization.

You will possibly consider that some of the work done is not appropriate to inspection, but it has always been the normal duty of the Inspectorate to perform the functions of consulting engineers and also to cover other activities which are not inspection.

The title of the Inspectorate was itself a misnomer, as a great volume of the work inspected was not electrical or mechanical. I was once told by a high official in the Ministry of Supply that " Dustbin " would be a better name. This was after " Jerricans," foodpacks, insecticide sprayers, prefabricated bituminous surfacing (for covering the surfaces of aerodromes) had been added.

The Inspectorate was organized into Headquarters, which provided common services, such as drawing office, metallurgy and chemical laboratories, gauges (issue and repair), workshops and included the Equipment Branch dealing with contract demands, preparation, printing and issue of specifications, drawings and parts lists, and three Divisions, each under a Deputy Chief Inspector (Engineer, Telecommunications and Vehicles).

These Divisions were subdivided into groups, each under an Inspector, Class I, and further subdivided into a number of Sections each under a Deputy Inspector, with a number of Assistant Inspectors and subordinate staff.

In addition there were twelve District Officers with Assistant Inspectors and staff drafted from the various divisions to deal with the various classes of stores.

The maximum strength of the department was 5,339, including clerical staff. I cannot give the value of the work inspected, but it may interest you to know in one year the Engineering Division inspected over £200,000,000 new stores. At one period inspection notes were being cleared at an average rate of over 20,000 a week.

The Inspectorate, in addition to inspection of new equipment, was responsible for the sentencing of all equipments returned to Central Ordnance Depots at home, and inspection after repair. Staffs were maintained at the Central Ordnance Depots for this work and the examination of equipments from U.S.A. and Canada and to assist the R.A.O.C. in identification, etc., of stores.

The Equipment Branch was responsible for completing technical details on contract demands, the preparation, in conjunction with the appropriate division, of the majority of the specifications, printing and issue of drawings, issue of modifications allocation of catalogue numbers to equipment and parts to enable the R.A.O.C. to handle, preparation of parts lists (many of which were illustrated and which enabled the troops in the field to identify and demand correct spares by name and catalogue number), and in conjunction with the Scales Branch, R.E.M.E., spares lists, by which provision of spares was made to enable adequate spares to be available with the equipments.

The preparation of parts lists for all equipments was a major task, for one wireless set alone the list contained 177 pages of typescript and illustrations, and 14,000 copies were required. The consolidated list of nuts, bolts and washers consisted of 750 pages, with 5,000 copies, equivalent to 20 tons of paper.

Owing to the great advance made in engineering developments, such as higher speeds, use of high tensile steels and other alloys, plastics, welding, high voltage and frequencies, and electronics, inspection had to continuously develop new technique and plant to cover adequately the inspection. A fully equipped metallurgical laboratory, complete with X-ray and chemical departments, became essential.

In service, equipments had to meet and operate in conditions which are not met in civil practice. Essential qualities were robustness, ease of transport, operation in rain, mud and sand, and be capable of operating in temperatures varying from arctic cold to tropical heat with humidity of 95–100 per cent. The high temperature and humid conditions produced many new problems, such as fungus growths affecting telecommunication and electrical equipment. The normal rust-preventing protection was found to be useless in conditions that would occur, say in New Guinea.

Naturally, it was the Inspectorate's function to provide tests and, when failures occurred, to try and get the cure.

In dealing with the inspection of such a diverse range of stores, which in the Engineering Division covered practically every type of civil, mechanical and electrical store or equipment in the telecommunications radio, line signal, radar, cables, electronic devices and electronic gun fuses, and in vehicles,lorries, cars, trailers, bicycles for all Services, testing after assembly of

imported vehicles, breaking down and boxing for shipment, the type and methods of inspection employed had to be varied to suit the store.

It would be impossible in the time available (and I should bore you if I attempted) to go into the various methods of inspection and the reasons for their adoption. Generally, the article was inspected at stages of manufacture and a final inspection at works on completion. It might be a full 100 per cent, or a percentage. The principle we adopted was to do the minimum inspection necessary in our opinion to ensure serviceability and make the maximum use of firms' inspection staffs. This was constantly reviewed in the light of experience. It did not follow that the same inspection was employed at two or more firms making the same article.

During the whole war there was, as you are aware, a very great shortage of gauge and tool-room capacity. Our policy was to use firms' production and/or inspection gauges and fixtures to the greatest extent possible and to restrict the provision of special inspection gauges for complete assemblies and composite parts, where general interchangeability was required. I suggest that the problem of production and inspection gauges is well worth close study in order to obtain a common gauge.

I will now briefly deal with a few examples of the work done by the three divisions.

Engineer Stores

The Bailey bridge in its various forms made an outstanding contribution to military operations. Therefore I am going to deal with the inspection of it at some length. The inspection problem was a formidable one. It involved the control of the quality of mass-produced bridging to an accuracy which had never been attempted in ordinary bridge or structural steel work.

The prototype trials were completed in the autumn of 1941, and contracts were placed immediately. Production started almost at once and gradually rose to a peak in the middle of 1943, when approximately 6,000 panels per week were produced, with the corresponding number of other components. Some firms produced 500 panels a week besides components. The class of work was foreign to many makers, and the accuracy required was far higher than had ever been attempted at structural steel firms.

The panel, which is approximately 10 ft long and 5ft. high and weighs 570 lb., is constructed of standard 4 in. by 2 in. channels and 3 in. by 1½ in. joists with heavy lugs made from rolled slab to form the male and female lugs. The factors of safety used in military bridging made it imperative that such points as accuracy of the intersections of the neutral axes of the various members should be closely toleranced and that the distances apart of the four main panel pinholes should be held ± 1/16 in. on the 10 ft. horizontal dimension and ± 0·025 in. on the 4 ft. 9 in. vertical. The tolerance on the holes themselves was ± 0·005 in.

Trammel type gauges were used having one pin sliding in a fixed bush and the other in a bush carried by a sliding tolerance box. The pins themselves were turned to a long taper.

Altogether a total of fifty-one firms produced panels in varying quantities and, with a few exceptions, every panel was gauged. The exceptions were those firms where large quantities were produced and the drilling was done on sets of pillar drills set up specially for the purpose, forming, as it were, part of the drilling jig. In these cases only a percentage of the panels were gauged after successful production had been attained, and it was generally found that it was sufficient to check the first and last panel on every shift. It was usual in cases of this kind to correct any errors which had crept in

owing to slight movement of the drilling machines, even though the product was still well within the tolerance band.

The maintenance of the toleranced dimensions was not the greatest problem, however. The high tensile steel was required to have a yield point of not less than 23 tons per sq. in., but in order that the steel might be weldable under ordinary mass-production conditions it was necessary to hold the carbon and manganese contents and that of the total other alloying elements, if used, within certain close limits, and this gave the steel makers a considerable amount of trouble at a period when their anxieties were great. It was inevitable that certain casts of steel, which were slightly above the limits for weldability or approaching those limits, should reach the manufacturer of the components, and very great attention had to be paid by the inspectorate to the welding which was done on this material. The welding of the male lugs to the panel was, from the start, considered a most important operation, and a very rigid procedure was observed whereby test welds were made periodically by each operator and were sectioned and examined microscopically. Only welders approved by the Inspectorate after tests, in accordance with the Advisory Service of Welding Memorandum No. 10, were used on any of the work, and those employed on the welding of panel male lugs had to pass special tests representative of the joint they were to make.

Owing to the low factors of safety employed on military bridging, major items of equipment are subjected to proof load before acceptance. In previous designs the application of a proof load had given little trouble, but it was not so easy to design a method of loading which would stress the B.B. panel in such a way that the test could represent overload on the conditions which might obtain wherever the panel was situated in a bridge girder. The obvious way was to test the panels as part of a girder, moving them along one by one from the position of maximum shear to the position of maximum bending moment, and so to the other end of the girder. The value of the load which had to be applied under such conditions was approximately 50 tons, and this in itself presented a formidable problem. A test rig was designed whereby a girder was supported at both ends and the load applied to the second panel thereof through a special framework from a Bailey bridge pivoted at the other end and carrying in the early days a flat railway wagon loaded with pig iron and running on rails. In this way it was possible to vary the load, but when certain experimental figures were obtained the moving load was replaced by a fixed one of pig iron. Ultimately two such test rigs were in operation, but even they could not cope with the toal output of panels and though for a period it was necessary to be content with the testing of only a percentage of the panels produced, this was never considered to be satisfactory and in 1943 one of my inspecting engineers designed a suitable small test rig which was ultimately installed by eleven major panel manufacturers. As a result we were able to test a total of 494,925 panels out of 696,544 produced. Although a number of panels failed in test, no failures occurred in Service use. Panels that failed in test were sent back to manufacturers and put on show ; the psychological effect was excellent.

Bridging demonstrations, which showed the need of accuracy and workmanship, were arranged, and firms' representatives attended and erected portions themselves. I am convinced that these shows were most valuable. The worker likes to know how equipment is used.

Much attention has been given above to the B.B. panel because it is the fundamental component and the most important member in any B.B. structure. It was not thought necessary to proof-load any other components,

but great attention had to be paid to the welding of a large number of them, for the same high-tensile steel was used in many cases. The most important thing among these were the ramps, where there are some awkward welds, connecting mild-steel webs with H.T. longitudinal members. Early experimental tests showed that there was an ample factor of safety on the panel pins, provided these were sound, and in consequence no load tests were made, but every pin was passed through a crack detector. The panel pins are made of alloy steel having a yield point of not less than 50 tons per sq. in.

The total number of panels produced was 696,544. The total amount of steel used in the Bailey bridge programme was about 400,000 tons, of which about 50 per cent was high tensile structural steel.

In passing I should like to mention that the experience obtained in manufacture and inspection proved invaluable in the Mulberry Harbour project, when 22 pier heads, 10 miles of floating bridge and 286 beetles were manufactured in six months from date of order.

Jerricans

The late President Roosevelt referred to the production of these as "one of the high spots of British war production." The original idea was an old British patent and was developed by the German Army as their standard petrol can. A number were captured in North Africa, and their obvious value gave rise to a demand that rapidly became clamorous. The German article was used as the basis of the British design, but the design eliminated certain weaknesses of the German pattern. The can holds 4 gal. of petrol. It was used in addition as a container for water, certain explosives, and other liquids, the internal paint lining being varied to suit.

In the middle of 1942 the Ministry of Supply was presented with a demand for millions of cans and also for plants to manufacture in theatres of war overseas in order to save shipping space ; 200 finished cans took up 230 cub. ft. as against 6 cub. ft. in sheet steel. By October the weekly production in this country was 18,000 ; by April, 1943, it had jumped to 300,000, and by July, 1943, to 500,000.

There were fifty-seven separate operations necessary to make a can, and eighteen inspection points were required in addition to air pressure test and final inspection on complete can.

The total number of complete cans produced in this country was 48,248,957 involving more than 49,000 tons of sheet steel and 5,000,000 gal. of paint. 100,000,000 identification tags were produced. In addition all the necks and filler caps for overseas were manufactured in this country.

During manufacture, inspection was essential to ensure that the cans were properly welded and painted, no bubbles of paint inside, which might flake off, and the complete can petrol-tight. Petrol tightness was tested by immersing the can in hot water, which produced an internal air pressure of 5–7 lb. per sq. in.

It is of interest that in spite of rough handling in transit to, and at, filling stations the leakers were only about 2,000. The cans were capable of being dropped full of petrol 15 ft. without developing leaks and were refillable.

Tropicalization of Electrical Stores

Stores for use in the Far East were originally required to be to the makers' normal tropical standard of manufacture and packing. The campaign soon brought to light the inadequacy of this standard. Reports showed that approximately one in six of equipments reached the troops in serviceable condition and, furthermore, the useful life was a mere fraction of what it

should have been. Electrical equipment was perhaps the most adversely affected. Steps had to be taken immediately to get over the troubles and " inspection " played a major part in investigating the causes and producing palliatives or cures.

There were two main aspects of the problem :—

(*a*) The handling and storage facilities during and after landing operations were only of the roughest and most primitive kind. Tropical rains followed by tropical sun, and the continuous high temperature, changes of day and night, leading to condensation, soon damaged equipments.

(*b*) Electrical equipment deteriorated very quickly in operation, due to the high humidity, etc.

In both (*a*) and (*b*) the nature of the deterioration was similar, destroyed or reduced insulation, instruments filled with water, metal parts corroded by oxidization and/or electrolytic action. In addition, the conditions encouraged the growth of fungi on organic materials of all kinds.

As manufacturers had been making and installing equipment in tropical countries for years without trouble, they were considerably surprised, to say the least.

The necessary improvements fell under five broad headings :—

1. *Prevention of Rusting.*—By the elimination of ferrous metal wherever possible. Painting, with special paints, of unavoidable ferrous metals on thoroughly cleaned and treated surfaces, or in the case of small parts such as springs, screws, nuts, etc., by plating them with zinc or cadmium, or preferably passivated zinc.
2. *Prevention of Corrosion in Non-ferrous Metals.*—By ensuring that where dissimilar metals must be used in permanent contact one was not more electro-positive to the other than 0·4 volt. By protecting metals very susceptible to corrosion with zinc, cadmium, nickel, or in the case of aluminium, by anodising.
3. *Prevention of Mould Growth.*—By elimination of organic material, wherever possible, or impregnating during manufacture with a fungicide. The complete sealing with special air-drying bakilised varnish, which contained a fungicide, of all windings, coils, sheet insulation, etc. The varnishing with the same varnish of the interior surfaces of machines, switchgear, etc., to provide a high hard gloss surface without crevices.
4. *Waterproofing.*—Hermetically sealing of instrument cases.
5. *Packing and Preservation.*—Special packages and packing methods were evolved together with the application to the stores themselves of selected preservative compounds.

You will appreciate that in order to arrive at the best solution regarding materials and treatment to be used, a vast amount of testing had to be done. A few manufacturers set up test arrangements to suit their own particular requirements, but the bulk of the work was done at the inspectorate.

* * * *

I have covered in a short time a very vast subject and as I look back on it now I often wonder how we managed to get through what we did without breakdown or serious delay. In casting my mind back, however, I am always vividly conscious of the one outstanding factor which made our job possible ; I refer to the very high standard of workmanship of the equipments produced in such vast quantities under difficult war conditions by the

engineering industry of this country. Inspection was made possible by the immensely conscientious national effort made by all those concerned, male and female, who were actuated by the one motive of ensuring that each individual job was a good one. For this saving factor I wish to express not only my personal appreciation and thanks, but those of all my staff. Our thanks are especially due to the firms' inspection staff and the delegate examiners, both of whom took a great load off us, and, in fact, without their co-operation and help we should not have been able to have got the job done.

Inspection is a subject which, with its varied problems, new technique and methods, deserves a more prominent position in the engineering industry and a greater consideration both by managements and engineers if we are to meet the competition that will occur in the future, and if we are to repeat that immense contribution to national security should the unfortunate necessity again arise. In the commercial world it is doubtful if we can ever attain mass production on the scale of the United States of America, and we shall have to rely more and more on quality. We shall have to rely on the continuance of that high standard of British workmanship which no other country has ever approached.

I hope, therefore, the lessons learnt in war on the need of adequate inspection at all stages of manufacture and the keenness shown during the war by all employers and employees will continue in peace, so we can show the world not only " Britain can make it, but that " Britain can make the goods in quality as well as quantity."

THE RECONSTRUCTION OF SALONIKA HARBOUR

By Major E. G. H. Jeffery, R.E., T.A.

Introduction

SALONIKA is the second city in Greece and the second largest port. Situated at the extreme north of the Ægean Sea, it serves the whole of Northern Greece ; also to some considerable extent, Yugoslavia.

During the first World War, in 1917, a very large section of the town was burned down, some fifteen thousand houses and other buildings being destroyed. British troops rendered valuable assistance to the population and did much to save the town.

In 1941, when the Germans came to the assistance of the virtually beaten Italians, and invaded Greece from Yugoslavia, and when British Empire and Greek forces were eventually forced to withdraw, a certain amount of demolition work was carried out by British Sappers in Salonika and district.

During the period of the occupation certain Greek patriot forces, individuals and small detachments of Force 133 and other special service personnel continually harassed the German L. of C., and carried out further demolitions.

In 1944 when the Germans were finally forced to withdraw, after the landing of British troops in Southern Greece, they carried out a carefully prepared and systematic system of destruction as they withdrew.

This article deals with the part played by British, and to a small degree by Indian Engineer troops, who were selected for the reconstruction of Salonika port, and the rehabilitation of Public Utility services in Salonika and district.

The Reconstruction of Salonika Harbour

On the 10th November, 1944, the L. of C. Engineer troops, whose principal task was the reconstruction of Salonika Harbour, entered the port.

The A/C.R.E. accompanied by the Adjutant, immediately went ashore to carry out a reconnaissance of the harbour area. The scene which confronted us was one of complete and utter chaos and destruction. This deliberate demolition of the harbour and installations must have been one of the Germans' most successful and thorough. An idea of the general state of harbour, buildings and installations can be got from Photo 1.

The harbour consisted of a main quay 1,300 ft. long, running east and west, known as Customs House Quay, from which stretched out into the bay, East and West Moles, the East Mole being 650 ft. long and the West Mole 830 ft. long, the whole being covered by a breakwater 1,700 ft. long. The harbour entrances were 630 ft. off the East Mole and 450 ft. off the West Mole. West of the main harbour was the coal quay, 800 ft. long, and still further west a partially constructed new quay. Plate I (at end of article), is a reconstruction of an accurate survey of the harbour area and town quay. It shows the actual position and size of all craters, also the block ships and other vessels sunk by the Germans.

As I intimated previously, the whole of the East and West Moles were completely destroyed throughout their lengths, the craters being almost continuous. The breakwater was breached in fourteen places, and the coal quay was completely destroyed (see Photo 2). The interior of the new quay had been dredged out by the Germans for use as a submarine basin. Practically all the harbour transit sheds and warehouse buildings of the steel frame, brick panel variety, were extensively damaged. The harbour railway system was so thoroughly destroyed that not one single length of rail remained intact and not one single locomotive, wagon or coach was operable. This also applied to the entire railway system of Greece. Crane rails in the harbour area were practically non-existent. Of approximately 18 steam cranes of 2½, 5 and 10-ton capacity, only three remained. One of these a 10 ton-Stothert & Pitt crane, was successfully tipped into the sea by British Sappers in 1941, was salvaged by the Hun and repaired and again demolished by him when he withdrew in 1944. A 2½-ton crane was recommissioned by fitting a boiler which we recovered from the roof of one of the transit sheds, it having been blown there by the force of the demolition.

The electric lighting and power supplies to the harbour were non-existent, as were also the water supply mains.

The original construction of the quays was briefly as follows :—The sea bed was dredged to a firm bottom, stone pitching was then tipped to form a good level foundation. On this foundation large precast concrete blocks of about 40 tons weight were placed, and were laid up in tiers to H.W.M., above which dressed granite blocks were placed, the back being filled with earth and rubble and surfaced with granite sets.

The reconstruction by Royal Engineer troops assisted by local Greek labour commenced within 48 hrs. of disembarkation. Our first task was to reconstruct the East Mole, in the shortest possible time in order that relief and military supplies could be off loaded, which for the time being were being brought ashore in lighters and "*Z*" landing craft. Two special ramps for the reception of "*Z*" landing craft were constructed in the first two weeks.

The craters on the quay frontage were up to 45 ft. in width and often to a depth of 12 ft. below H.W.M. Fortunately the rise and fall of tide in this part of the world is only 18 in. to 2 ft., which simplified matters considerably.

Photo 1.—A general view of the main quay and West mole, taken from the East mole.

Reconstruction of Salonika harbour 1

Photo 2.—A general view of the Coal quay.

Photo 3.—A view of the East mole and breakwater after seven weeks' work.

Reconstruction of Salonika harbour 2 & 3

The method of reconstruction of the East Mole, where speed was the essential factor, was as follows :—The sides of the craters were built up in reinforced concrete to deck level, the front of the crater was then spanned by a fabricated girder approximately 18 in. by 10 in. These girders were salvaged from demolished buildings. From this girder 4 in. mesh steel torpedo netting was draped down the front and across the bottom of the crater. On the inside of this net a dry mix filled sand bag wall 4 ft. 6 in. thick, reinforced with ½-in. M.S. bars placed vertically and horizontally, was built to H.W.M. Above this, shuttering was erected and mass concrete cast to deck level, incorporating bollards where necessary. The crater was then back filled with rubble and surfaced (see Plate II). All 16 craters on the East Mole were repaired in this manner. The East Mole transit sheds were repaired and re-roofed, railway and crane rails re-laid, and an overhead system of electric flood lighting installed. A 6-in. water main was laid and connected, with 2-in. branches for watering ships. This work was completed and the first Liberty ship tied up early in January, seven weeks from the commencement of the task (see Photo 3). Well over 1,000 tons of debris and surplus German boom defence stores of all descriptions were removed from the East Mole.

During the time the Royal Engineers were reconstructing the East Mole, the Royal Navy Boom Ship *Barclose* was busily engaged lifting wrecks from alongside the East Mole and town quay, which catered for Caique traffic. In all, some forty-seven wrecks were lifted—a masterly effort. The *Barclose* was assisted by the Greek 60 and 100-ton floating shearlegs, which for some unknown reason were not demolished by the Germans. These shearlegs were also used extensively on the harbour reconstruction. It was quite a common sight during the first few weeks to see the *Barclose* with shearlegs on either side steaming out to the graveyard with a lift of anything up to 300 tons on the slings, her propellers flapping in the breeze, very much to the concern of the Greek crews on board the shearlegs, particularly when the main winch cables of the *Barclose* snapped, the *Barclose* leaping into the air, and the shearlegs all but joining their friends in the graveyard.

Another R.N. salvage vessel, the *Prince Salvor*, using her own diving teams, cut and removed approximately 100 ft. from the bows of the block ship lying between the East Mole and the breakwater, by the use of made up ribbon charges. When this work was in progress, a flag signalling system had to be adopted in order to ensure that none of the divers working on the harbour works were diving at the time charges were detonated.

The second block ship off the East Mole and the block ship off the West Mole were later salvaged.

One of our R.E. Works Sections during this same period, employing Greek labour, commenced the reconstruction of the Harbour breakwater (see Plate I), a very essential part of the reconstruction programme, but to some extent a disappointing task as the first three months' work was all below water ; there was, therefore, no visible progress.

The method of reconstruction was as follows :—All debris was first removed from the craters by the use of mechanical shovels mounted on lighters, the larger debris was removed by the 60-ton shearlegs, directed by Greek divers. Following the clearance, stone pitching was dumped from hopper barges until a firm level bottom was obtained. Precast concrete blocks were then placed in position by the 60 or 100-ton shearlegs and were laid up in tiers to H.W.M. From this point two 2 ft. thick random rubble walls were built up on either side of the breakwater to a height of 6 ft., the area between the two walls was then filled with mass concrete to promenade level. The wall on

the seaward side was then built up approximately 6 ft. and capped with dressed granite coping stones.

The second stage of the harbour quay reconstruction was carried out in a similar manner to the breakwater (see Plate II). The craters were cleared of debris by mechanical shovels and dragline excavators, any protruding precast blocks were cut off by placing bore hole charges and cutting off the protruding sections. 40-ton precast concrete blocks were then placed in position and built up to water level. On top of the blocks, timber shuttering was erected and mass concrete was cast to deck level, incorporating 50-ton bollards where necessary. The back of the crater was then filled with rubble and surfaced.

Some 450 ft. of the Main Customs House quay were also cleared of debris and reconstructed, providing lighter berths adjacent to the first two transit sheds and the centre bay of the Customs House which we used as a marine workshop. Also some 200 ft. of the West Mole were reconstructed and were used as a coaling berth. In all, some 1,850 ft. of quay frontage were reconstructed.

The harbour transit sheds and warehouse accommodation were extensively damaged. Stanchions had to be pulled back into position and underpinned as necessary. In certain cases they had to be replaced. Wall panels had to be rebuilt in brick. Practically every roof truss had its lower chord fractured. These had to be windlassed back into position and fish-plates were welded on. Roof purlins and tile battens had to be made good and the roofs entirely retiled.

The type of debris which had to be removed from the roofs of these buildings included vehicle chassis, cranes and boilers and portions of railway rolling stock. 47,750 ft. super of transit shed and 80,950 ft. super of warehouse accommodation were reconstructed.

Assisted by the Greek state railway platelayers, a single line railway system throughout the harbour area was repaired and put into commission. The damaged sections of rail were cut out and short lengths of rail inserted, bolted up with fish plates. Outside the harbour area where the rails were set in chairs on sleepers, the rails were cut off square by oxy-acetylene cutters, pulled back through the chairs and bolted up with fish plates. The crane rails were almost entirely renewed.

The Greeks managed to get two locomotives and about twelve trucks into commission after about two months' work.

An overhead system of flood lighting was installed on the West Mole and the transit sheds on the East Mole and Main Quay were completely rewired for electric lighting.

Due to shortage of fresh water supplies in the harbour area, a considerable amount of concreting was done with sea water. Apart from a slightly slower curing process as compared with fresh water, the concrete proved perfectly satisfactory, although no actual strength tests were carried out.

Photo 3 shows the East Mole after seven weeks' work with the first Liberty ship tied up off-loading relief and military supplies.

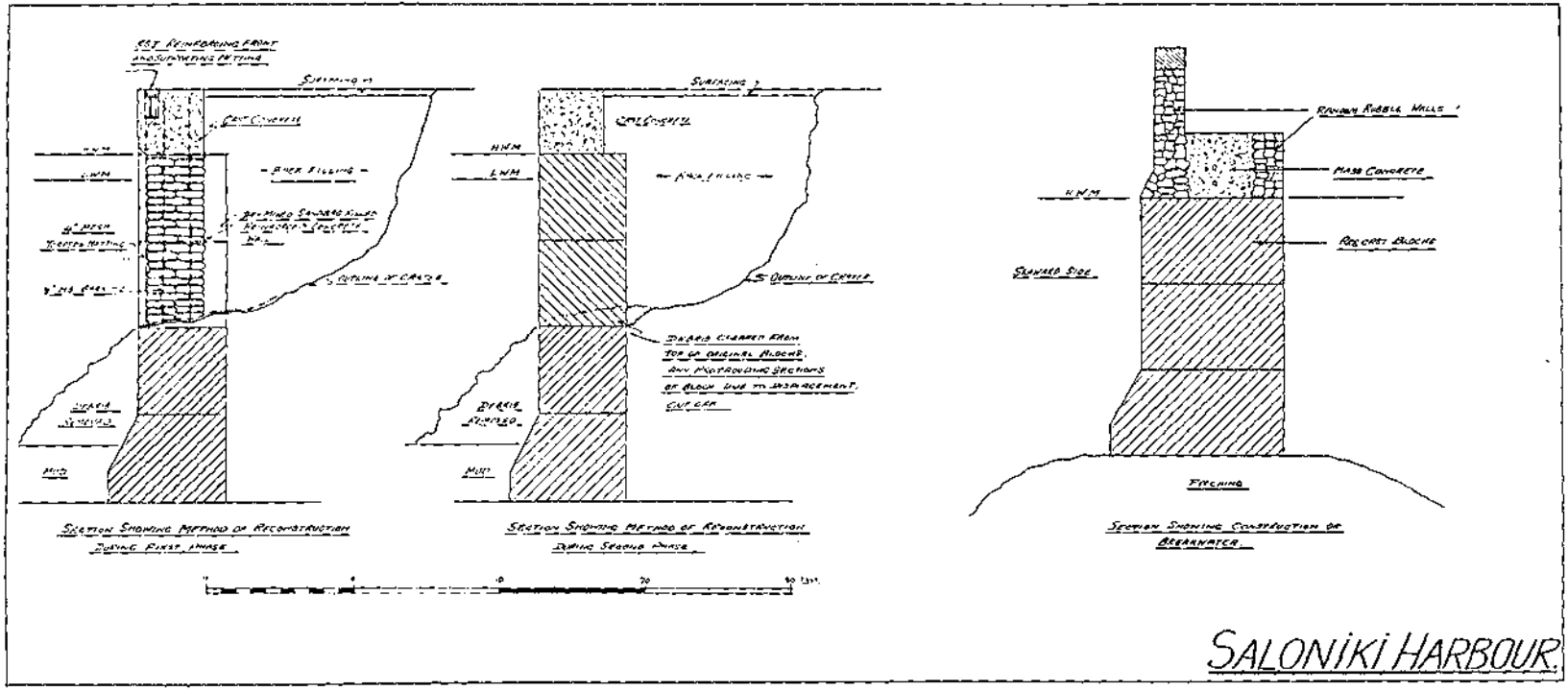
All the above work was, of course, considerably handicapped by the Elas troubles, strikes, disputes over rates of pay, food and clothing.

The new quay, which I mentioned previously, was constructed in approximately 30–36 ft. of water, and afforded a good berth for Liberty ships. It was, therefore, decided by the Port Committee to construct a quay 50 ft. wide throughout the length of the partially constructed quay which was 800 ft. in length (see Plate III).

The suction dredger *Strymon* after a considerable amount of repair was set

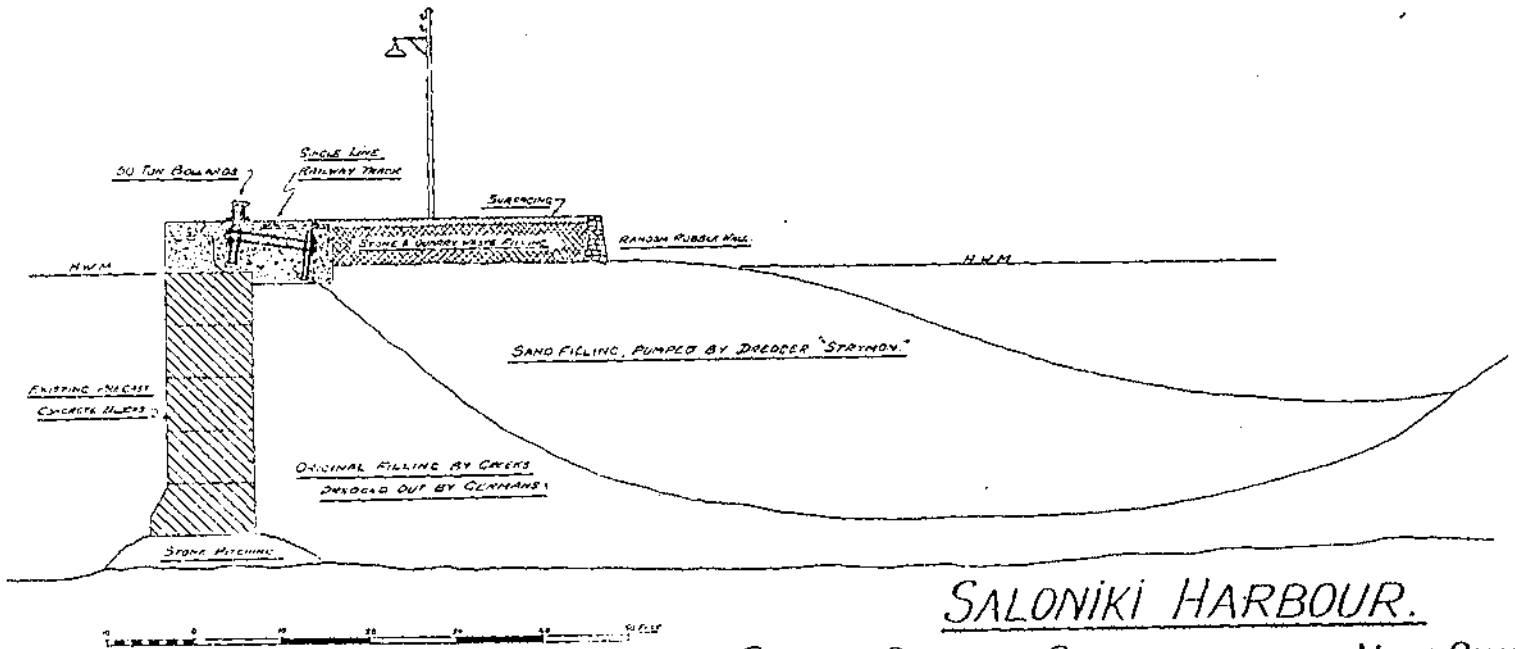
Photo 4.—A general view of the new quay during construction. The 24" delivery pipe line from the dredger Strymon can be seen on the right.

Reconstruction of Salonika harbour 4



SALONIKI HARBOUR.

Plate II.



SALONIKI HARBOUR.

SECTION SHOWING CONSTRUCTION OF NEW QUAY.

Plate III.

to work pumping sand into the basin through a 24-in. floating pipe line. The interior of the main pump casing, approximately 5 ft. diameter, had to be built up about 1½ in. by electric welding. The end of the pipe line can be seen in Photo 4, which also gives a general view of the new quay during construction. A quarry which we operated 11 km. from the harbour, provided all the necessary stone pitching, not only for this task, but for the whole of the harbour reconstruction works. The 11 km. of 24-in. gauge railway had to be reconstructed and a signalling system installed. Also all the steam and Diesel locomotives had to be repaired. All this work was done by our Sappers.

Sand for the harbour works was obtained from the dry bed of the river Gallikos, about 4 km. from the harbour, a branch line from the quarry railway was installed alongside the river, the trucks being filled by drag line excavator.

The method of construction of the new quay was to pump sand into the basin at a rate of 1,100 tons per hour, to form a consolidated sandbank at H.W.M., with a natural angle of repose of sand on the seaward side. In this sandbank stone pitching was tipped and built up to road level and surfaced. On the seaward side of the filling a retaining wall was constructed from random rubble having a batter of 5 degrees from the vertical. Approximately 18,000 tons of stone were quarried, transported and dumped into the new quay.

The existing main quay wall had to be built up in reinforced concrete a further 18 in., in order that the construction would conform to, and form part of, the final construction of the new quay.

A standard gauge single line railway, a 6-in. water main with 2-in. branches for watering ships, overhead flood lighting and 50-ton bollards were installed. The whole scheme was completed in about twelve weeks.

In addition to all the harbour works, we also salvaged and commissioned a considerable number of German 200 h.p. " F " boats and motor launches, and a 500 h.p. Diesel tug, which the salvage vessel *Barclose* lifted for us, not to mention the rehabilitation of power stations, water-pumping stations, refrigerating plants and bakeries, the repair of certain main roads, within a 35 km. radius of Salonika, the reconstruction of road bridges, both steel and reinforced concrete, also within this area, and the provision of all military accommodation and installations ; also the reconstruction of airfields, which involved mine-lifting and bomb disposal on a large scale.

The Engineer troops under the command of 178 C.R.E. Works, who took part in this reconstruction programme were :

277 R.E. Works Section.
110 (East Lancs) Army Troops Coy., R.E.
No. 1 Bomb Disposal Platoon.
No. 31 Mech. Equip. Platoon.
No. 31 R.E. Stores Section.

The undermentioned units were also under command for a short-time and contributed to the work :

369 R.E. Works Section.
11 Fd. Park Coy., Indian S. & M. of the 4 Ind. Inf. Div.

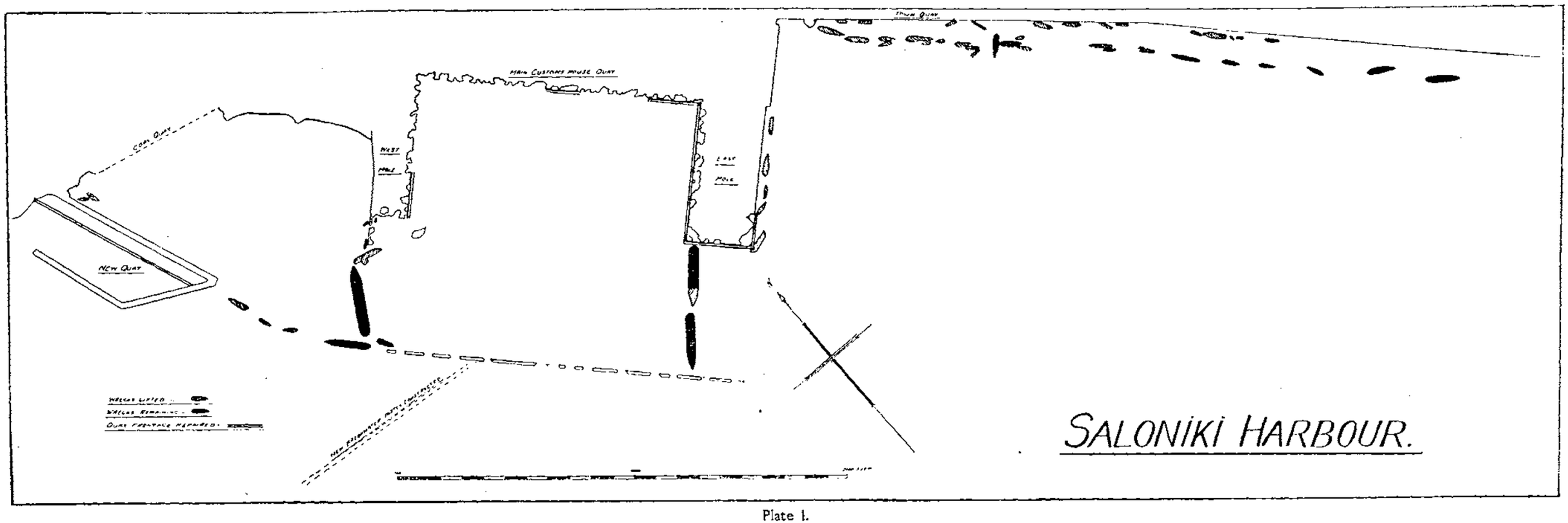

Coal Quay
New Quay
Main Customs House Quay
West Mole
East Mole
Town Quay
Saloniki Harbour.

Plate I.

THE MATERIALS PROBLEM FOR THE POST-WAR ARMY

By Lieut.-Col. J. V. Davidson-Houston, M.B.E., R.E.

" *When the children of Israel made bricks without straw,*
They were learnin' the regular work of our Corps. . . ."
(Kipling ; " Sappers.")

Introduction

IT is a truism that the execution of engineer work depends upon labour and materials, but it does not always occur to the engineer officer that the conditions limiting the supply of these materials in the post-war world differ widely from those operating during hostilities. In the late war, materials were limited largely by problems of transportation ; at the present time the restricting factors are cost and the existence of world shortages. Military requirements now have to compete with insistent demands on behalf of reconstruction and civilian consumption, and for this reason it is necessary that the system of priorities and allocation should be more widely understood than is at present the case.

Allocation

(*a*) *Between Government Departments.*—The available quantities of raw materials in short supply (which in effect means all engineer materials) are allocated periodically at the Cabinet Materials Committee, at which every interested Department is represented by its Priority Officer. The War Office representative is known as the Principal Priority Officer (P.P.O.) and belongs to Q.M.G.'s department. The Committee is responsible to the Lord President of the Council, so that appeals against its decisions have to go to Cabinet level for adjudication.

Allocations of materials for army use are made in two ways

(i) Direct to War Office.
(ii) To Ministry of Supply on behalf of War Office.

Direct War office allocations are for fabrication under military arrangements e.g. timber packing in Ordnance Depots, orders by R.E. for structural steel. Ministry of Supply receives allocations for fabrication of all stores (e.g. weapons, furniture), which are demanded as finished articles by the War Office and are not further considered in this paper.

At the Materials Committee meetings the P.P.O., who has collected the estimated requirements of the Directorates concerned, bids against the other departments ; but as there is never enough to go round, and the Government is allotting the highest priorities to building, fuel and export, the War Office has considerable difficulty in obtaining its needs, and practically every department has to accept a cut.

(*b*) *Within the War Office.*—At the beginning of the late war, allocations of timber and steel were sub-allotted within the War Office by F.W., as the major user. Other user directorates complained, however, that this system inevitably benefited the Engineers at the expense of the other users, and in 1942 the War Office Materials Control (W.O.M.C.) was set up under the P.P.O. The duty of the W.O.M.C. is to call for periodic quantitative estimates from army users and collate them for presentation at the Cabinet

Materials Committee ; on receipt of an allocation, the Control sub-allocates it to the users and is responsible for seeing that the allotments are not exceeded.

Whereas timber and steel were originally the only materials to be handled in this way, post-war shortages have steadily added to their number, one of the latest additions being linseed oil for paint and putty.

Methods of Control

These are :

(i) financial
(ii) quantitative.

The revival of peace-time Army Estimates makes it necessary for each directorate to obtain financial approval for the value of its estimated annual consumption. On the basis of these estimates, quantitative requirements are periodically submitted to W.O.M.C. when called for. As every material involves a different part of the Government machinery it will be of interest to outline the procedure in each case.

Timber

Great Britain's normal sources of timber were North America and the Baltic. Supplies from the former area are at present restricted by considerations of currency, by the effect of the shipping and coal strikes, and by the high internal demand in Canada and U.S.A. Export and other difficulties have also prevented a complete restoration of trade with Russia and the other Baltic countries. Supplies have therefore been unable to keep pace with the rising demand.

W.O.M.C. calls for quarterly estimates of softwood (in standards), hardwood (in cu. ft.) and plywood (in f.s.) from the following users :

Director of Engineer Stores ..	(Manufacture of stores at home and total requirements overseas).
Chief Engineers of Home Commands ..	(Works services).
Director of Supplies and Transport ..	(Packing supplies ; W.D. Craft).
Ordnance ..	(Packing stores).
Director of Military Training ..	(Training stores).
Army Kinema Corporation ..	(Seating).
N.A.A.F.I. ..	(Furniture, building of N.A.A.F.I. clubs etc.).
Medical, Welfare ..	Small quantities for miscellaneous purposes.

These are collated and bid for by P.P.O. at the quarterly Materials Committee, the War Office demand being scaled down by 25 to 50 per cent. P.P.O. subsequently holds a meeting of the army users, at which the above cut is distributed as equitably as possible between them, and a small reserve retained by W.O.M.C. for contingencies. This reserve is always released before the end of the Period, since balances cannot be carried into the next quarter.

D.E.S., when requiring timber for use in Stores Depots, and C.E.s of Commands, when ordering work on contractors, submit an application in each case to W.O.M.C., which authorizes or amends it and passes a copy to the Timber Control department of the Board of Trade. At present certain sizes and qualities of timber are reserved for building, and W.O.M.C. must

ensure that it does not authorize their use for other purposes. Timber in overseas Commands is obtained either from War Office allocation or by local purchase. In the former case D.E.S. applies direct to Timber Control, which supplies up to the authorized amount, and then sub-allocates to Commands. The large requirements of Middle East have hitherto been obtained by direct purchase in East Africa, but this has recently been put upon a more regular basis by making the Board of Trade financially and contractually responsible, while allowing the local military authorities to make the arrangements on the Board's behalf.

Iron and Steel

Here also the supply cannot meet the demand, the contributing factors being mainly the American strikes and the coal shortage in U.K.

In this case, user directorates submit quarterly estimates broken down into

Sheets
Plate (tin, terne and black)
Sections
Castings

The necessity for increasingly strict control is tending to call for even further breakdowns, and it is now proposed to demand separate estimates for Strip.

Allocations are made at the quarterly Materials Committee, and sub-allocations made by W.O.M.C., but this time the Materials Control has to issue, through the Chief Engineer concerned, a Form "M" to each contractor requiring to consume or acquire steel on behalf of an Army service, specifying the quantities and types of steel authorized. The department responsible for the general control of iron and steel is the Ministry of Supply, to whom the "M" Forms eventually return by way of the steel supplier.

Linseed Oil

The main uses of this oil are for paints, varnishes, distemper and putty, and the present world shortage is largely due to the unwillingness and inability of India (the main producer) to ship the quantities required. Linseed, it should be observed, is also a source of edible oil.

In this case, there are three administering Departments :

Ministry of Transport	..	(for railways and shipping).
Ministry of Works	..	(for buildings).
Ministry of Supply	..	(for general industry).

Linseed Oil used by the Army comes mainly into two categories :

(*a*) Paint and distemper applied by contractors in U.K.
(*b*) Paint and distemper required in overseas commands, and paint etc. applied by military or direct labour in U.K.

The former is obtained by the contractors by means of authorizations from the Ministry of Works, and P.P.O. is not directly concerned. The latter category, however, is met by a direct allocation to the War Office, which is administered by the Ministry of Supply. Under this arrangement, paint is demanded by Ordnance from the Ministry, and is subsequently issued to the Engineers and other consuming Services ; distemper is demanded direct by D.E.S. from the Ministry of Supply.

The problem of linseed oil is not confined to shortages ; the strictness of inspection and the ponderous official procedure is making suppliers unwilling to quote for the tenders of Government Departments, so that the receipt of an allocation is no guarantee of availability.

Building Board

Considerable quantities of laminated, insulation and other composition boards are now being used in building, and to a certain extent relieve the shortage of plywood. Building board is administered by the Paper Control, and allocated by the Cabinet Materials Committee at four-monthly intervals. W.O.M.C. collects estimates from D.E.S. (comprising overseas requirements), from Chief Engineers of Home Commands, and from the N.A.A.F.I. (for their building uses) and sub-allots the War Office allocation between them. These users then obtain from W.O.M.C. the necessary authorizations for their contractors, who attach them to their applications to the Paper Control for release of board.

Unallocated Materials

There is, in addition, a great number of building materials, such as bricks, cement and lead, which are not departmentally allocated but are controlled by the Ministry of Works. They are obtained in Home Commands by applying to the Regional Building Committee for a Priority symbol for the particular works project ; subsequent demands on supplies are then supported by this symbol. Requirements for overseas are demanded in bulk by D.E.S. on the Ministry of Supply, which endeavours to place contracts for them.

Road-making materials, such as bitumen, are controlled by the Ministry of Transport and are obtained in a manner analogous to the above.

Housing Fitments

A very great variety of stores, varying from baths to door-knobs, is controlled by the Director-General of Housing Supplies in the Ministry of Supply. In Home Commands, building contractors, having received a priority symbol for the particular project from the Regional Building Committee, quote this symbol when demanding from suppliers. D.E.S. obtains his requirements for overseas by direct demand on the Ministry of Supply, who place the contracts.

Conservation

Various methods have been adopted in this country to conserve the limited supplies of materials, chief of which are :

(*a*) *The Timber and Steel Economy Sub-committees* of the Cabinet Materials Committee, the members of which are representatives of the Controls and consuming Departments primarily concerned. These sub-committees recommend to the Materials Committee such measures as they consider will economize material.

(*b*) *Economies in utilization* are enjoined on Departments by the Materials Committee through the Priority Officers, by Ministry of Works and Ministry of Supply circulars, or by directives to Ministers from the Lord President himself.

(*c*) *Investigations into stocks* are held under the authority of the Lord President, so as to ensure that these are kept to a minimum during this period of stringency.

(*d*) *Surpluses*, whether at home or abroad, have to be declared to the Ministry of Supply, which gives instructions for disposal. Conversely, stores otherwise difficult to obtain may sometimes be acquired from surpluses known to the Ministry.

Priorities

In order to cope with the major building projects in Home Commands, the Q.M.G. has had to lay down priorities for the supply of materials, and these are notified from time to time to those concerned.

Conclusions

The situation described is not an easy one, and is likely to subsist for several years. The traditional resource of the Royal Engineers will be taxed to the utmost in designing and carrying out work with the maximum economy of materials, and in improvising where requirements prove to be unobtainable. Stores officers must remember that their margins will be cut very fine, and that there is little room for error in estimating quantitative requirements. Annual estimates, moreover, besides having regard to the financial ceiling, must take into account the quantities likely to be available.

Lastly, it must be realized that the P.P.O. has small chance of obtaining the required allocations unless he has a convincing story with which to back his claims. It is useless to demand large quantities of stores without the fullest supporting details. Failure to produce such information means that we get neither the stores nor the money to pay for them.

SOME UNUSUAL PROBLEMS IN AIRFIELD CONSTRUCTION

By Colonel T. W. R. Haycraft

The Effect of Frost

"FROST heaving" is a phenomenon rarely met with in this climate, but in cold countries it presents serious problems.

The most spectacular form occurs on light soils with a high water content during very rapid freezing at low ground temperatures—round about 0°F. The effect is for the surface to be raised to a height varying from a few inches to as much as 18 inches above the ground supported on pillars of ice with horizontal strata of soil frozen into them all the way from top to bottom. It is quite easy to tread on this raised surface, which appears quite normal but will carry no weight at all and lets your foot through. The result can be most startling! The writer has not been able to find any reason for this very curious action.

The more common form of frost heaving, and the one that presents an engineering problem, is the expansion of ground as it freezes. The amount of the expansion varies with the water content but, curiously enough, this expansion may be far greater than it would be with 100 per cent water content—i.e. pure water. In fact the writer had positive evidence of the surface of ground frozen 4 ft. deep subsiding one foot when thawed out, a reduction in volume of 25 per cent as compared with 10 per cent for pure ice. Another curious thing is that the surface rises and falls with the temperature even though the latter never rises above freezing point. The worst conditions of movement occur on peat.

The writer had to build a runway in Iceland on a peat bog, the only available site. The decision was made in January and the runway was to be operational

in June. The ground was then frozen 4 ft. deep and the local engineer stated that the surface would sink at least a foot in thawing out. He did not expect the frost would be out of the ground until June.

Dimensions were specified as 1,000 yds. × 100 yds. It was decided that, since no amount of concrete or reinforcement would save the surface from breaking up when the ground thawed out, it was better to do a 50 yds. width to a low specification, do the other 50 yds. *after* the frost had gone out of the ground and hope to complete that by the time the first 50 yds. went out of commission. The first 50 yds. could then be broken up and relaid. It was a gamble but it came off.

A tarmac surface was considered in the hope that, by daily rolling, it might be persuaded to follow the ground as it subsided. However, this was rather problematical and, as the supply of cement and aggregate was easier than bitumen and macadam, the idea was abandoned.

The survey party had a continual nightmare. Every morning they found their level pegs had risen during the night and every afternoon they went down again! Movement was inconstant and unpredictable. Reference marks had to be made on concrete columns taken 6 ft. down to a gravel bed. With the very slight falls possible the rule was to work to a margin of error of ¼ in. but this proved quite impossible while frost remained in the ground.

Due to the insulation afforded by the concrete surface and under-layer of lava the ground under the first 50 yds. width did not thaw out until the end of July and by that time it was unsafe to drive a car over this strip at more than 5 m.p.h. There were steps nine inches high between adjoining slabs; in places along the edge, where the concrete surface remained suspended while the ground subsided underneath, the writer saw a man crawl in under! In several places the concrete sank leaving bumps standing up with cracks radiating from the highest point. Assuming that these were caused by rocks just under the surface and founded on solid ground so that they did not follow the frost movement, two or three of these bumps were dug out but no rocks were found. The erratic behaviour under frost conditions of the apparently quite homogeneous peat remained a mystery to the end.

The local engineer was confident that once a surface had been laid under normal conditions subsequent frost would not cause any heaving. There seemed to be no obvious reason for this though it was borne out by the fact that a concrete road laid a couple of years previously, as well as various concrete areas laid the previous summer, showed no sign of movement. The writer left before the following winter and cannot say whether the concrete runways gave any trouble. He would be very interested to hear from any R.E. officer who can tell him.

Bearing Power of Peat

Peat which is not contained in any way will carry a limited load in elastic compression. This load depends on the fibrosity of the peat and its water content. Bigger loads—even railways—can be carried by spreading the load until the unit loading comes within the elastic limit. This can be done either by using a conical dry fill placed on a layer of brushwood, or similar material, to prevent mixing or by using a semi-rigid carpet. The dry fill must be of such a nature as will give a wide angle of spread and must not be too heavy. Furnace clinker is the best material and ordinary soil the worst. The semi-rigid carpet is difficult because it must itself be elastic enough to allow the peat to carry the load.

A useful property of peat is that, due to its fibrous nature, it does not readily flow round corners even under a load much in excess of the elastic limit.

The bearing power can therefore be greatly increased by containing the peat locally.

In the case of the runway mentioned before, the majority of the peat had sufficient bearing power to carry the specified load on an eight inch unreinforced concrete mat over one foot thick lava filling. In places however, this was not the case, in fact some of the peat was so bad that even light tractors were bogged down. Three courses were open :—

(*a*) To heavily reinforce the concrete mat
(*b*) To contain the peat in some way
(*c*) To support a less heavily reinforced mat on short concrete pillars taken down to the gravel, about 6 ft down.

Sufficient reinforcement was not available for (*a*). (*c*) would take too long and would almost certainly delay completion.

An experiment was tried of cutting cement drums down one side and across top and bottom and opening them out like an oyster. These were then bedded down on the peat convex side up and covered with lava 9 in. deep over the highest part of the drum. It was found that the surface would then carry a 10-ton road roller in perfect elastic compression vastly in excess of what the peat would carry if free to move, and this before the addition of the concrete mat. It was found essential that the tins should be dug into the peat so that the latter completely filled the tins and left no voids. Inverted 4-gallon petrol cans with the top cut out were also tried but, though they greatly increased the bearing power, they would not bear a road roller consolidating the lava covering.

It is of course well known that local containing raises the bearing power of poor soils, but what may not be generally realized is that the containing medium need not have any great strength—the cement drums used were of very thin gauge.

The matter of rust was considered but it was thought that, buried in peat with air excluded by the concrete covering, the drums should last for many years.

The use of these cement drums was particularly fortunate because the piles of empty drums formed a flying obstruction and their disposal was a problem in itself.

Other Points of Interest

All drainage for the first 50 yds. width was excavated in frozen ground with air picks. Experiments were carried out with bore holes and gelignite, but the frozen ground was so tough that the charges would not break it out. Two sticks of gelignite down an 18-in. bore hole either blew out the tamping or made a camouflet. Apart from the enormous quantities of powder that would have been required, boring, either with a cruciform head or with a point, was so slow that no time would have been saved.

An unusual material was used for the carpet under the concrete mat. This was a natural burnt clay, burnt by volcanic heat. It was very similar to furnace clinker, though somewhat heavier. Apart from being a light material and saving transport it was a good heat insulator and would help to keep frost out of the ground.

With the help of Soyers Stoves, calcium chloride and a 6 in. covering of lava concreting was carried on down to 25° F. of frost. Occasionally the surface was caught but only required removal of the top inch or so and refloating. The layer of lava clinker undoubtedly helped by insulating the fresh concrete from the frozen ground underneath.

The work was of such high priority that the C.R.E. had a call on any officer or O.R. in the Force whose qualifications could be utilized. An officer commanding a Field Troop, R.A. had been manager of a big garage in London. He was put in charge of maintenance of all plant and ran an organization on up to date lines. All men who had worked as drivers or mechanics on crushers, excavators, etc., in civil life were called in. All unit G. 1098 transport was made available when not otherwise employed. Units were given definite tasks bringing lava, aggregate or sand from sites near their locations. Whenever the Divisional General and his staff paid a visit, they took their coats off and did half an hour's work.

The A.P.M. ran a very efficient organization regulating road circuits and speed limits for the benefit of both the roads and the vehicles. A Sapper officer was specially detailed to watch the roads, especially during a temporary thaw, report repairs required and instruct the A.P.M. A Supply officer kept an eye on misuse of vehicles.

The first 50 yds. width of runway was completed three days before schedule. Due to the fact that a week's warning of this accelleration had been given a squadron of Beaufort bombers was brought up to Wick, took off as soon as the " all clear " was received, re-fuelled in Iceland and went off after the *Bismark*. This was a good example of the value of close control over progress. Actually the Squadron landed eight hours after completion, and one of the aircraft left the pattern of its tyres on the last bay poured !

An erection party from Dorman Long was laid on by the Air Ministry to put up a couple of big steel hangars. Without waiting for the party to arrive a scratch party of steel erectors was collected from all arms. By the time the civilian party arrived one hanger was already up, to the great credit of a Pioneer Corps Serjeant, an ex-foreman steel erector. This party worked very long hours regardless of the weather.

The colloidol method of concreting was tried out but failed due to the fact that it was found impossible in such a rush job to maintain a constant quality and size of aggregate. Every source of aggregate was being exploited to the full, ranging from the best crushed screened stone to " all in " sea sand and shingle not entirely free from seaweed. By the time the runway was operational and the specification could be tightened up the colloidal machines had been diverted to other work. Another difficulty was that the only sand that could be used was volcanic, rather course and very sharp, which wore out the impellors of the colloidol machines. Sea sand was obtainable but this was mixed and required screening. Hand screening was too slow and no mechanical screen was available.

An interesting experiment in connection with colloidol concreting is worth mentioning. In order to test the efficiency of pouring the hanger foundations (6 ft. deep through peat to gravel bed) with colloidol machines a short length was dug and filled with dry stone with vertical pipes left in. As no colloidol machine happened to be available at the moment a slurry of the same consistency was mixed in an ordinary mixer and poured out of a can. Although the experiment was completely successful as far as producing a dense concrete was concerned it was found to have no strength whatever ! A very good illustration of the effect of excess of water in an ordinary mix as opposed to a colloidol mix. Unfortunately the O.C. of the company doing the job hated colloidol and was delighted. Nothing would persuade him to use colloidol machines for the job and, being a very eminent Civil Engineering professor, the C.R.E. had perforce to give way although the job was ideal for colloidol machines.

PRODUCTION OF ENGINEER STORES IN ITALY

(October, 1943, to October, 1945)

By Colonel A. H. Glendenning, O.B.E., B.Sc., A.M.Inst.C.E.

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IN October, 1943, after the fall of Tunis and the capture of Sicily, the Allied armies in the Mediterranean had settled down to the long and arduous battle for Italy. This required large quantities of Engineer Stores, both for fighting the battle, maintaining the lines of communication, and building the large base installations necessary to maintain the 5th and 8th Armies, who were fighting a major campaign far away from home with a submarine infested sea as their link of supply. In the early stages all major stores came from home, but by October, 1943, the planning of the base installations to deal with 22 British Divisions or approximately 1,000,000 men was well in hand. This plan involved the provision of 7½ million square feet of covered storage space ; 27,400 hospital beds and camps for 350,000 men. Of these, half of the storage space had to be new, quarter was found in existing buildings and quarter was provided by repairing bomb damaged buildings. In one case we repaired a completely wrecked steel works to make a R.E.M.E. base workshop. In another we converted a bomb-blasted spinning mill into a similar shop. Only one-eighth of the hospital beds were to be new construction, but three-quarters of the camp accommodations had to be built.

Planning was almost complete by December and work was well advanced. The programme called for completion of all the major work by March/April, 1944

During the winter, 1943–44, efforts were being made to produce as many Engineer Stores as possible in Italy to save shipping and speed up the works' programme : this required large quantities of timber, cement, bricks, steel and other Engineer Stores. This work had been started on a contract basis with a small staff controlling two Engineer Sections, each of one officer and 29 to 30 men. It was apparent by February,'44, that if the works' programme was to be completed the Italian slow method of production would have to be drastically altered, and with this in view Production Staff was increased and given the 80th South African Engineer Base Workshop, consisting of 12 officers and 200 men under the command of Lieut.-Col. Campbell-Pitt. The plan was that where the Italian management was inefficient we would take over the works and run them by direct labour. The South African officers, N.C.O.s and men were marvellous and by November, 1944, we were employing directly and by contract 15,000 Italians, controlling 85 odd works and were producing 35,000 tons per month of Engineer Stores.

In this paper I do not propose to deal in detail with all our different shops and factories, as I want to concentrate on the major item, steel. But to give you some idea of the types of production we did handle, I will first mention briefly some of the works other than steel. We operated cement works at Taranto, Modugno, Barletta, and Spoleto : these works were all the dry rotary kiln type with the exception of Taranto, which had an old-fashioned vertical kiln and produced only 1,000 tons per month, while Modugno with

two modern rotary kilns produced 7,000 tons per month. Our total output was about 15,000 tons per month ; the demand was about twice this figure, but in spite of that everyone managed.

We had eight woodworking shops in Molfetta, Bari, Naples and Rome, employing about 1,000 men and handling about 2,000 tons of timber per month. In these shops we made bridge decking, camp structures, hutting, caravans and furniture. To supply this timber demand and to meet the needs for structural timber required for bridging and camps, we relied on timber from Calabria. Here there is a considerable area of good pine up to 80 years old, mostly in the Sila Range, which rises to 5,000 feet above the Calabrian coastal plain. These mountains are studded with small timber mills, which we tried to operate on a contract basis paying for the timber delivered to Crotone Port or any of the stations on the coastal railway from Reggio via Catanzaro and Crotone round to Taranto. Unfortunately the mill owners did not consider that it was good policy to meet our monthly timber demand of 15,000 tons. The pine of the Sila would be much more valuable if kept for supplying the Italian black market after we had gone. Also the workers were short of clothes and food, while transport and mill spares were a major trouble. The result was that in October, 1944, the Italian output had fallen to some 2,000 tons per month, and they had made up their minds to stop for the winter. They told us that the mills never had been operated in the winter and that, owing to the snow, it would not be possible. The only way out was to take the mills over. In early November, 1944, we requisitioned 35 saw mills, sacked the management and set to work, and by January, 1945, we were getting over 15,000 tons per month aided by a general transport company, snow ploughs and other mechanical equipment. As well as those activities, we operated fifteen brick works, two nail works, a nut and bolt factory, four Bitumen Emulsion factories, and one small rubber works, chiefly required to make belting to keep the wheels in our factories turning. Practically all the works mentioned, with the exception of the saw mills and cement works, had been either hit by bombs or demolished by Jerry, and starting up in most cases meant rebuilding and repairing the machinery or installing machinery saved out of other factories.

These direct labour factories were all managed by South African N.C.O.s and sappers, who controlled the labour and supervised the output. While every effort was made to keep book-keeping to a minimum, there was in fact a large amount of this to be done. We had a monthly wages bill of some 14,000,000 lira, or, at 400 lira to the pound, the exchange then operating meant £35,000 for wages alone. To help to maintain our production we costed all our works on labour only and put the factories on the same type of production in competition with each other. This competition kept all the N.C.O.s in charge of factories on their toes and produced considerable enthusiasm. We also kept records of repairs and improvements made in all works to assist in the final hand-back to the Italian owners.

I now wish to turn to the major part of our work—steel and bridges. In January, 1944, we had three steel fabricating shops—one in Castellammare, one in Naples and one in Bari. The Castellammare works was by far the largest : it had been a railway wagon building works covering some 22 acres ; it had a sheet rolling mill, good foundry, heavy and light forging shop, nut and bolt works, machine shop, woodworking shop, tin plate mill and a shell pressing shop. Jerry had left all this a tangled mass of damaged rolling stock and smashed machine tools. While these works were under repair, we started the fabrication of steel shedding, mine gapping stores and special parts for continuous Bailey bridges, all out of existing salvaged stocks of structural steel.

It was, however, obvious that if our steel fabrication and shed production were to continue, we had to start immediately making steel. The only works in the liberated area were one small rolling mill with a 25-ton Siemens furnace at Giovinazzo, near Bari, and the Ilva Works of Torre Annunziate, and Bagnoli. None of these works was operating and both the Ilva works had been seriously damaged.

Ilva Bagnoli, covering 297 acres, 25 per cent roofed, in pre-war days produced annually 300,000 tons of coke, 300,000 tons of pig-iron, 350,000 tons of steel in blooms and ingots and 150,000 tons in section. The excess of blooms and ingots was used in the Torre Annunziate Works. The plant available for this production consisted of a 24-ton per hour coking plant, three blast furnaces, one Thomas convertor, five 65-ton Siemens furnaces, two electric furnaces, and one Dolomite calcining plant. The whole of the above had suffered very heavy damage, with the exception of the Dolomite plant, and could be of no immediate use to the armies.

Ilva Torre Annunziate covered 88 acres, 11·4 per cent roofed, and produced annually 50,000 tons of ingots and 80,000 tons of rolled steel from three 30-ton Siemens furnaces and five rolling mills. In addition, they had a large wire drawing and nail production plant. This plant was less seriously damaged than Bagnoli, but one continuous rolling mill was completely destroyed and others were stripped. In other words, the plant could be of no immediate use to us, but the owners were encouraged to get ahead with the repair of two Siemens furnaces and two of the light rolling mills.

Giovinazzo Steel Works, which had not operated since May, 1943, was undamaged. This works is a very small antiquated plant, designed for the manufacture of light sections up to 4 in. by 2 in. channels, equipped with one hand-fed 25-ton Siemens furnace, heated by producer gas from three manual-fed gas producers. The works was examined in detail by Major Evans, R.A., in January, 1944, and on his recommendation it was decided to start up as soon as possible. The management of the Giovinazzo Works proved quite incapable of any determined action, and repairs went so slowly that the plant was taken over on a direct labour basis by 80 E.B.W., S.A.E.C. on 1st April, 1944, and the Siemens Martin was first tapped on 13th April, 1944.

From April, 1944, until July, 1945, Giovinazzo produced an average of 900 tons of sections per month for the Armed Forces.

The spring offensive of 1944 broke the German line at Casino. Anzio was relieved, and the armies during the summer raced forward past Rome to Florence and the Appenines. In spite of the German haste, they hardly left a single road or rail bridge in Italy from Naples to Florence. The immediate need of the battle was met by Bailey, but something more was necessary to fill all the subsidiary gaps and to eventually relieve the Bailey Bridge for use again. During the period April to June, 1944, I had been playing with the design of a locally produced steel bridge, but due to lack of experience and time I had not got very far. By the merest luck Major John Lander, of the London Underground, arrived in Italy in command of a Tunnelling Company, after a long blasting in Malta. Brigadier D. L. Anderson C.B.E., Director of Works, knew him of old and immediately obtained his services. Lander at once got down to design proper. Tied to our limited sections and limited welding facilities, after one or two shots, plunged for a copy of the Bailey in mild steel.

The new bridge, called the " Flambo," was designed for a special purpose—that of replacing Bailey so that the Bailey Bridge in the rear areas could be lifted and used again by the forward troops. It is understood that the reproduction of the Bailey at home was slowed down by difficulties in welding the

high tensile steel and by the necessity of meticulous care in proving the accuracy of all fabrication. As our bridge was not to be used for operations we were able to cut out a large part of the checking, and if a part did slip out not true to size or shape, it could be fitted on site or dropped in the river. The bridge being of mild steel was considerably heavier than the Bailey. The standard bridge, which was a 60-ft. single storey, double panel bridge for 40-ton load, weighed 32 tons, while 130 ft. of double storey triple panel capable of carrying 24 tons weighed 91 tons. The main points of the bridge were as follows and are as shown in Plate I :

(i) Panel 10 ft. 6 in. × 5 ft. 3 in. out of two 4 in. × 2 in. channels forming the top and bottom cord with verticals and bracing out of 3 in. × 1½ in. R.S.J.s weight 900 lb.
(ii) Panel pin 9 in. × 2½ in. diam MS. pin weight 12 lb.
(iii) Transom 10 ft. 3 in. long, all riveted fabrication out of angle and flat weighing 421 lb.
(iv) Stringers consisting of three 4 in. × 2 in. R.S.J. laced together with 2 in. flat, forming a frame 10 ft. 6 in. long and 1 ft. 9½ in. wide and weighing 250 lb.
(v) Deck 2 in. timber 11 ft. 9 in. random widths held in position by 6 in. × 6 in. timbers bolted through to the transom.
(vi) End posts, male and female, each fabricated out of two 4 in. × 2 in. channels complete with jacking brackets weighing 180/190 lb.

In addition are bracing frames, wind bracing, bearings, cord bolts, a complete kit of tools for erection, and a special adaptor post so that " Flambo " panels could be added to the one end of an existing Bailey launched across the river and the Bailey dismantled at the other side.

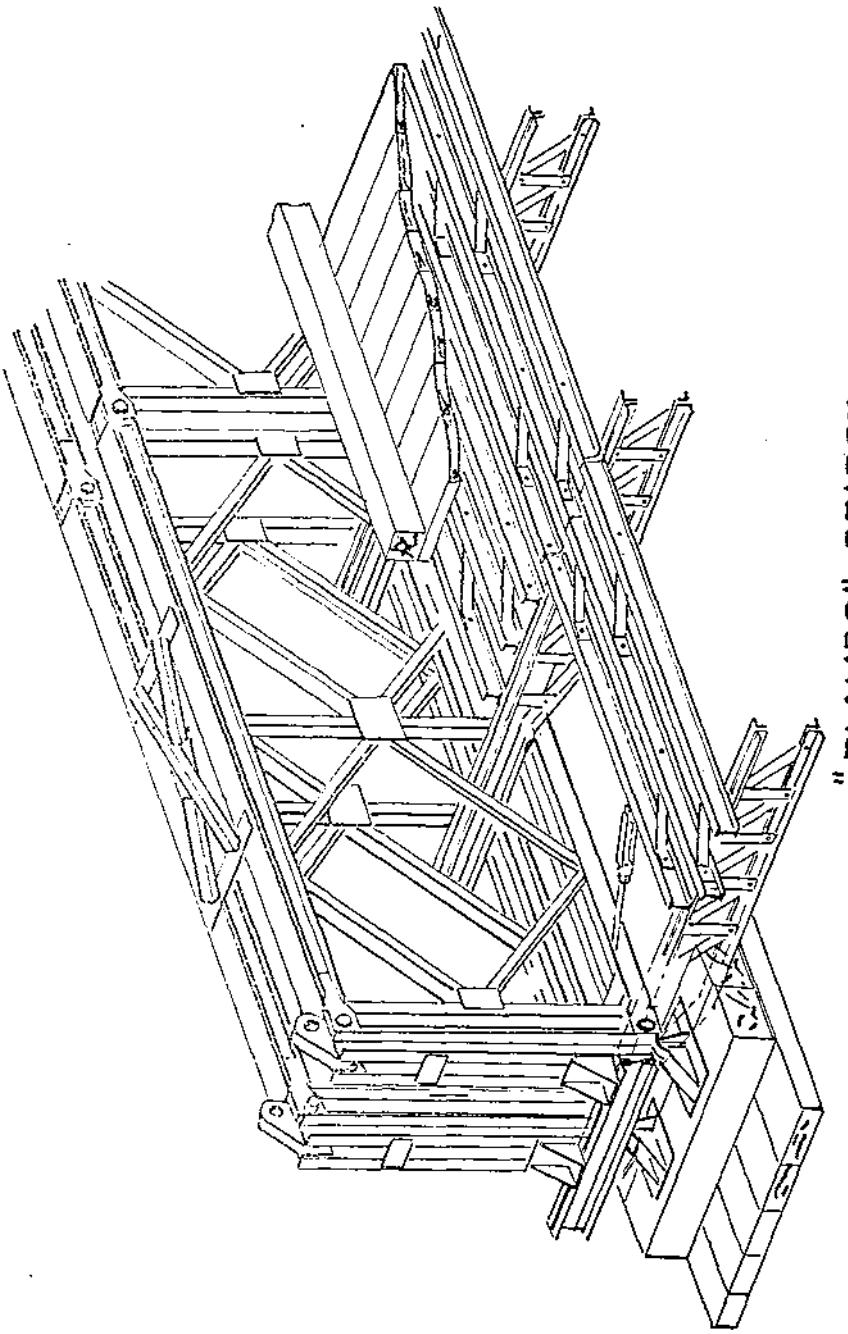
By September, 1944, Flambo bridges, 60 ft. span, 40 tons capacity, were coming off the production line at one per day. This job of design and fabrication by the Army of bridges on a mass production scale, involving the starting and running of the necessary steel works, the construction of fabrication shops and the setting up of a welding school to train Italian civilian welders, was a considerable undertaking, and its success was due to the efforts of Major Lander and Lieut.-Col. Campbell-Pitt with his 80 E.B.W.

It all sounds very easy in this paper, but the snags and bottlenecks which were encountered and overcome were legion.

The end connections of the panels consisted of three parts—two female lugs and one male lug, all forged. We soon found that our forging capacity was insufficient to cope, so we started up some damaged shell presses to assist, and at a later date got a plate rolling mill going and were thereby able to roll to the thickness of the finished article and cut the lugs out by oxy-acetylene on a profiling machine. Another bottleneck was the laziness of the Southern Italian. This was overcome !

Bridge production was now eating up our previously adequate supply of steel. In the meantime, the Terni steel works, north of Rome, had been liberated. This works was originally a large armament factory with heavy forging shops capable of producing guns of the largest calibre and equipped with presses up to 12,000-ton capacity. It had two plate mills, one capable of producing armour plate up to 14 in. thick. The plant covered 300 acres, was equipped with eight Siemens Martin furnaces, five electric furnaces, heavy machine shops and its own refractory brick works. Terni employed 10,000 people and produced 200,000 tons of steel per annum—10 per cent of Italy's total production. The furnaces operated on locally produced lignite rom the Morgnano Mines close by.

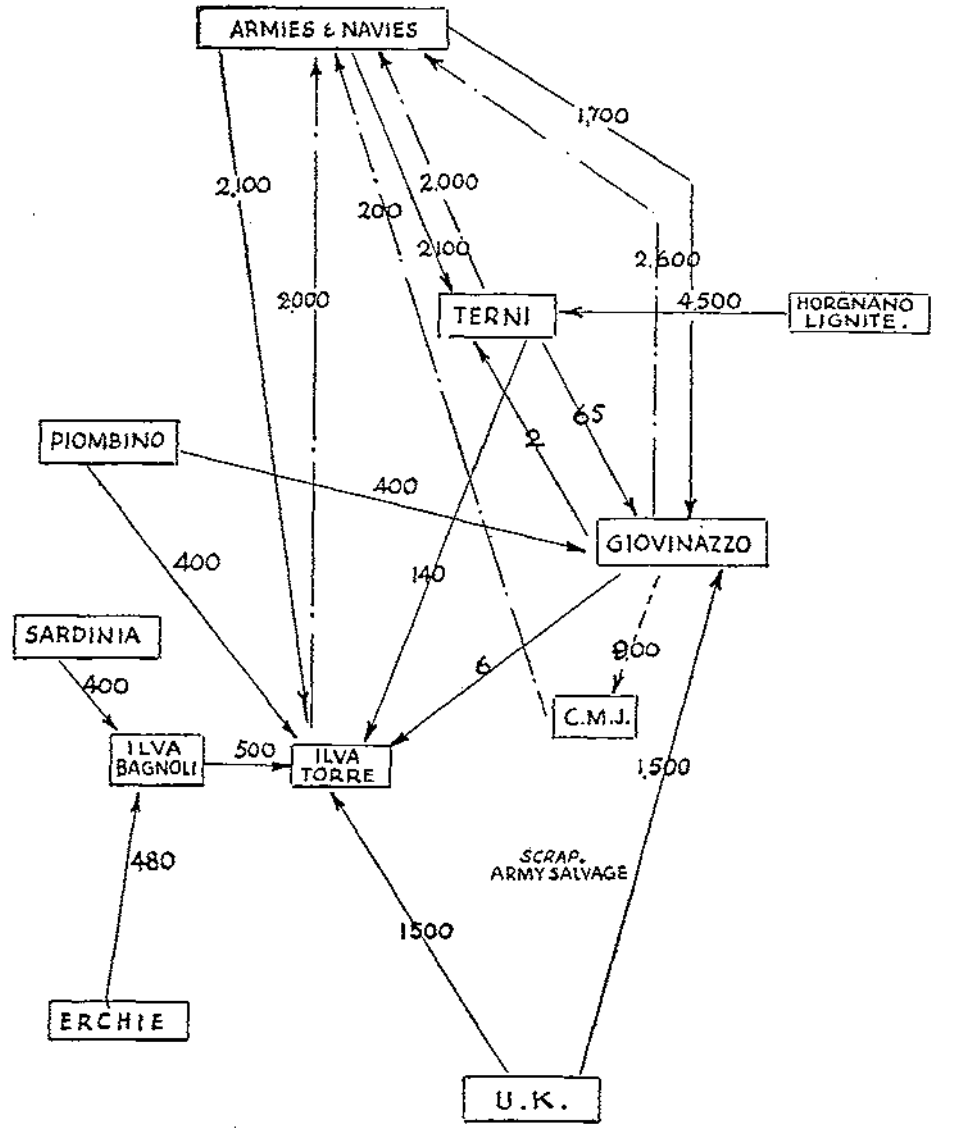
Plate 1.



"FLAMBO" BRIDGE.

Plate II.

ONE MONTHS MOVEMENT OF RAW MATERIALS & FINISHED PRODUCTS
FOR 6.000 TONS INGOT STEEL



In August, 1943, the works and Terni town had been bombed by the Allies. The damage to the works was slight, but the town suffered severely. The result was that the workers fled to the hills and the works closed down. After this, Jerry started systematically removing the plant. He took away all the electric furnaces, dismantled one blooming mill and part of the armour plate mill ; also the bombing had removed all the roofing and the machinery had been exposed to the weather for nine months. In June, 1944, repairs were started, and by September one 60-ton Siemens was working and the medium plate mill was in operation by 11th September. Further rehabilitation of this works was slow, due to the lack of electric power, Jerry having demolished the hydro stations nearby.

At this stage it was necessary to review the whole situation. The steel demands of the Allied Forces were about 1,000 tons of plate and 4,000 tons of sections per month, whereas production in September was 1,000 tons of plate and only 800 tons of sections per month. To meet this demand it was necessary to start up the Ilva Torre Annunziate works and operate the three mills—Giovinazzo, Ilva and Terni. If this was carried out, a production of 5,500 tons of steel per month could be obtained, but this involved the movement of 15,000 tons per month of raw materials and the collecting of all existing stocks of pig-iron, ferro manganese and ferro silicon, and the importation of 3,000 tons per month of coal.

Rail movement in Italy was very difficult owing to the state of destruction. Dolomite had to be moved along the coast by ship and fireclay had to come from Sardinia (diagrammatic movement shown in Plate II).

After considerable discussion, it was decided that the Director of Engineering Stores and Production, H.Q., A.A.I., should undertake the responsibility of supplying all the steel required by the Allied Navies, Armies and Air Forces in Italy. To attain this, development of the Ilva Torre Annunziate, Terni and Giovinazzo works was put in the hands of the 80 EBW, who also had to supervise the subsidiary works of Ilva Bagnoli and Ilva Falonica for the calcining of Dolomite and the making of rolls respectively.

By October, 1944, it was found necessary to cut down the variety of items being demanded to save the multiple changing of rolls and thereby increase production. To meet this need D.W., A.A.I. steel catalogue was produced, and all users were informed that they could have catalogue items only ; no other items would be considered.

Through the winter of 1944 production increased, and by January, 1945, we were making 6,000 tons of ingots per month with a planned programme for increasing this production to 8,000 tons per month by May.

Returning to bridge design, we were faced in the autumn of 1944 with the planning for the crossing of the River Po. During the winter months various types of assault equipment and special Bailey equipment were designed. These bridges demanded a vast number of special parts, which were all put into production. At the same time Major Lander was proceeding with the design of a 300 ft. span continuous suspension bridge, using Flambo parts for the main structure and piers. All the parts were made for 10 spans of this bridge, and although it was never put up as 10 continuous spans over the Po, one 300 ft. span was erected over the Arno and is there today.

By March, our bridge production had risen to two bridges per day, and some 200 60-ft. standard Flambo bridges had been made and large numbers of them erected to replace the Baileys, which were required for the final assault on North Italy.

After VJ-Day we were left with the steel industry of Southern and Central Italy on our hands. The straightforward method of getting rid of the Italian

steel industry was to walk out and leave them to it. Unfortunately the plants involved were living on a day-to-day basis, controlled by a central organization which was purely military. This organization planned and arranged for all the necessary movement of raw materials and fuel. It was obvious that if the military withdrew their control, the steel works concerned would close down in a very short time and would have left some 6,000 unemployed Italians to add to the unrest of the country. It was decided, therefore, that an effort would be made to arrange for the three companies concerned to form themselves into a cartel—at least for a short period: this cartel to take over the existing military organization. With this in view the managers of the various works were called to a meeting and told bluntly that if they did not form a combined office to deal with the steel industry we would withdraw our control and they would be faced with possible inactivity for some time to come. This action had its desired effect, and the three companies, Ilva, Terni and Giovinazzo formed what was called the "Ufficio Siderurgico di Collegamento." In order to assist this office to function, we transferred several of our military personnel to them for a period of one month and arranged in the early stages to be responsible for organizing the movement of their raw materials. By July, 1945, this organization was running satisfactorily and we were able to completely withdraw our control and hand the steel industry of Southern and Central Italy back to the Italian Government. Production at this date had reached 8,000 tons per month of ingot steel.

In order to carry out the hand-over just described, certain of the staff of the Directorate of Engineering Production and Stores were transferred to Allied Commission and were responsible for the planning of the complete steel industry of Italy, which had now been liberated. The first steps in this reorganization of the Italian steel industry were to carry our investigation of the statistics available to the Italian Government. These statistics showed that Italian steel production in 1939–41 was two and one-quarter million tons per annum, one and one-half million of which was produced in Siemens furnaces and three-quarter million in electric furnaces. Of the Siemens furnace production one-quarter was produced by the use of lignite and three-quarters on imported coal. Total imports required to produce the two and one-quarter million tons of steel were three and one-quarter million tons of raw materials: a further three and one-third million tons of raw materials were found locally. This included one and three-quarter million tons of local ore. Italian pig-iron was produced by electric smelting and in blast furnaces. An examination showed that by using the electric smelting and electric furnaces and lignite to the full, Italy could produce one million tons of steel with four hundred thousand tons of imported coal. Owing to the world shortage of coal, it was decided to arrange an Italian steel production programme based on the full use of electric power and starting off at the rate of one million tons per annum. With this object in view, Eng. Artigiani, of the Ilva Co., was sent to North Italy with Major Boger. On arrival in Milan they found that the Northern steel industry was already organized under the Commissione Industriale della Siderurgia. The engineers of this committee, in conjunction with Eng. Artigiani, produced the Programme Siderurgico Italiano, September, 1945/March, 1946. This programme was finally approved by the Italian Ministry of Industry and was put into force in August, 1945. Coke ovens were immediately started up, and it is hoped that the steel envisaged in the programme was in fact produced.

INDIAN ENGINEER ASSISTANCE GROUP

THE ANGLO-IRANIAN OIL COMPANY, ABADAN, IRAN

By Major D. A. Goldfinch, F.R.I.B.A., R.E.

I. Formation

In the latter part of 1943 it became obvious that the civilian labour available in Iran was inadequate to meet the needs of the construction programme for the Refinery Expansion Scheme at Abadan. This labour shortage was not only seasonal—due to the migration towards the crop growing areas—but was aggravated by the heavy demands in the area of the British Military authorities and the American base at Khoramshar, which was handling the bulk of the Aid to Russia supplies.

In the light of this information, the Anglo-Iranian Oil Company approached the Military Authorities with a view to obtaining assistance from Engineer troops.

The requirements of the construction programme, giving very careful consideration to the target dates for increased aviation spirit output, were discussed by representatives of the A.I.O.C. and of G.H.Q. Persia and Iraq Force.

The type of work to be undertaken, the construction and assembly of refinery plant as well as general building works, called for a high percentage of skilled fitters and steel erectors, together with carpenters, re-inforced concretors and a minimum of bricklayers. Such requirements were incompatible with the War Establishment of any particular Unit. It was undesirable to loan troops by trades as a Labour Pool, and a compromise was effected, decision being taken to loan one Indian Engineer battalion, one Army Troops company, one Artisan Works company (to be replaced at a later date by another Army Troops company) and four Artisan Pioneer companies.

Agreement was finally reached between A.I.O.C. Head Office and the War Office for the loan of these troops on a repayment basis for the period of construction of Stage III of the Refinery Expansion, with an option to retain them for Stage IV should the War situation necessitate such retention.

It was agreed that the execution of works, and the responsibility for their specification, should be through the Chief Construction Engineer of the A.I.O.C. and his Staff of Civilian Job Officers.

The Policy as regards employment of the troops remained a Military responsibility, and it was decided to appoint an Engineer Officer to co-ordinate the execution of works and the policy of employment. This officer was to be responsible for the organization and efficient utilization of the troops.

The collective designation of units engaged upon this scheme was agreed by A.I.O.C. as "Indian Engineer Assistance Group, A.I.O.C., Abadan." Major D. A. Goldfinch, R.E. assumed duties of Liaison Officer, I.E.A.G., with an office situated inside the Refinery, and the Group commenced work on 4th January, 1944.

It was agreed that all instructions and orders relating to works for A.I.O.C., covering both administration and policy of works, would be issued to Units by the Liaison Officer, while all other matters affecting Units' accommodation and military administration would be dealt with through the normal military channels.

2. Organization and Technical Control

The following Units formed the I.E.A.G. at the commencement of the programme.

49 (Royal Bombay S. & M.) Army Troops Coy., I.E.
No. 4. Engineer Bn., I.E. (H.Q. and four companys).
503 Art. Works Coy., I.E.
1266 Pnr. Coy.
1273 Pnr. Coy.
1274 Pnr. Coy.
1275 Pnr. Coy.

No. 503 Art. Works Coy. ceased to work with I.E.A.G. on 25th May, 1944, and it was then agreed that the second Army Troops company would not be required as a replacement.

1273 Pnr. Coy. were moved for operational reasons early in October, 1944, and 1303 Pnr. Coy. was sent as a replacement.

Under G.H.Q. Paiforce Administrative Instruction No. 63 (being the formation of the I.E.A.G.) the Pioneer companies were seconded from H.Q. Pioneer Group to Engineer Command, and a Pioneer Co-ordinating Officer was appointed to receive all orders from the Liaison Officer on behalf of the the four Pioneer companies. Capt. Bennett (O.C. 1273 Pnr. Coy.) assumed this duty until relieved on the posting of his company in October by Capt. A. G. Marshall (O.C. 1275 Pnr. Coy.).

The effective working strength of the I.E.A.G. can be scheduled as follows :

Tradesmen	400	(Grades I—III incl.)
Sappers ..	500	(Semi-skilled trades)
Pioneers ..	900	(Labour and Mates)
Total strength	1,800	

Early discussions between the Chief Construction Engineer to A.I.O.C. (later referred to as C.C.E.) and the Liaison Officer I.E.A.G. resulted in the more skilled tradesmen (mainly on W.E. of 49 Army Troops Coy.) being allocated to various sections of the Construction Dept. with a view to initiating officers and men into company (A.I.O.C.) standards and methods of carrying out work as soon as possible.

C.C.E. then arranged a works programme in consultation with Liaison Officer I.E.A.G. The I.E.A.G. officers and men were to work on construction sites under the direct supervision of civilian Job Officers, and such arrangements were issued in the form of I.E.A.G. Administrative Orders. These orders were distributed to all I.E.A.G. Units with copy to C.E. & D.W. Paiforce and also to Forces Liaison, A.I.O.C., enabling the two latter Depts. to maintain a complete picture of the programme.

In many instances it was considered essential for experienced Irani tradesmen to be filtered into works with I.O.R.s as the former had been employees of the A.I.O.C. for long periods and were fully acquainted with the works on hand.

From 26th August, 1944, all A.I.O.C. Job Officers and Irani artisans were withdrawn from I.E.A.G. works' sites and the Military Job Officers took full responsibility under the Liaison Officer, who maintained a close liaison for specification acceptance with the Senior Construction Superintendent. A.I.O.C. detailed one engineer to ensure delivery and supply of all stores required. This method of technical control gave greater satisfaction to the officers as they were then given full responsibility as Sapper officers.

3. Costing and Construction Records

All personnel of the I.E.A.G. were loaned to A.I.O.C. on repayment, and instructions were issued in G.H.Q. Paiforce Administrative Instruction No. 82 as to methods of recovery of cost.

Prior to the issue of this Financial Instruction discussions took place between C.E. & D.W., Pay and the F.A., and the Liaison Officer prepared a detailed analysis of the cost of each Unit. This was based on the W.E. and actual rates of Pay, Expatriation allowance, Batta, Washing and Hair-cutting allowance, Trade or Grade Pay, Pay of Rank, G.C. and P.P., and the results were consolidated as follows :

Army Troops Coy.	..	Rs. 1·77 per man per day.
Art. Works Coy.	..	Rs. 1·95 per man per day.
Engineer Bn.	..	Rs. 1·48 per man per day.
Pioneer Coy.	..	Rs. 1·17 per man per day.

These rates were obtained by taking the total cost per day and dividing by the War Establishment, excluding British officers. In order to allow for the War Service Increment w.e.f. 3rd September, 1944, all rates would have to be increased by Rs. 0·2 per man per day.

Rates for rations per man per day were supplied by S. & T. Dte., averaging 25·360d. per man per day for Indian rations.

A rate to cover clothing, medical and general stores, and medical and miscellaneous services was agreed by F.A. as 9½d. per man per day.

The charges for officers was agreed as actual cost, plus the daily rate for rations and miscellaneous services (less the allowance for clothing).

It was agreed that the accommodation camps should be purchased direct by A.I.O.C., and no charge was included in the costing for accommodation in view of this.

The movement and transportation of the units to and from Abadan was to be at cost and figures were submitted to the Liaison Officer I.E.A.G. by the Mov. and Tn. Dte.

For the purpose of costing and preparing Debit Vouchers (A.F. 1680) in the office of the Liaison Officer, daily records were maintained of the working strength and ration strength of each Unit, together with a record of all casualties affecting the officer strength with dates of assuming and relinquishing duties with I.E.A.G.

Quarterly returns showing the *average* daily ration strengths per month by units were submitted to A.I.O.C. Costs Dept. and to Pay Office Paiforce, together with a nominal roll of all officers—showing source of pay and effective dates. These figures were later abstracted by Liaison Officer I.E.A.G. on pro-forma and presented to A.I.O.C. with the voucher A.F. 1680. In the case of officers the pro-forma was submitted to Command Pay Office for the completion of the column showing officers' actual pay, and returned to Liaison Officer.

In view of the fact that the whole expansion programme was prepared by the Construction Dept. on man-day analysis, and the need for accurate progress records to be referred to London, it was essential for the Liaison Officer to maintain daily records of men working on respective sites. In order to do this a Daily Strength return was submitted by Units. This was then consolidated and submitted to Construction Dept. and Costs Dept.

In order to carry out works with every economy as regards man power, the C.C.E. submitted a schedule showing the man days allotted to respective jobs, together with the target dates, etc. By comparison of the daily strength

records with these figures wastage of man power could be checked and progress recorded in graph form.

As a further aid to economy, Military Job Officers prepared a weekly works table setting out the man-days to be utilized ; this was prepared in conjunction with the Progress Schedule.

4. Difficulties to be Overcome

The sudden allocation of large bodies of Indian troops to a civilian organization for the purpose of carrying out construction works under the control of civilian engineers and to civilian standards (and the A.I.O.C. naturally required works to their high peace-time level in view of the permanent and costly type of work) cannot be made without numerous difficulties arising.

The following are a few examples of matters that have to be faced, and it is only with considerable " give-and-take " that they can be overcome to the benefit of the works programme.

(*a*) The working hours were totally unsuited to Indian troops and entailed men working from 06.00 hrs. until 11.00 hrs. before having their first meal of the day. It was realized that the general refinery hours of several thousand Iranis could not be changed to suit the two thousand of I.E.A.G. without causing a break in the efficient supervision, delivery of stores, etc. and the situation had to be accepted. It was, however, agreed that on Thursday (when Irani labour works through to 12.00 hours without a meal break) the I.E.A.G. personnel would finish at the same time as their weekly meal break, i.e. 11.00 hrs.

(*b*) I.O.R.s were working on army rates of pay alongside Irani tradesmen and labourers who were receiving many times more pay for carrying out the same tasks. This did, at times, cause friction and necessitated careful handling by the V.C.O.s to prevent laziness etc.

The same was applicable to Officers working as Job Officers with civilian Job Officers drawing two and three times the pay, and in many cases less qualified due to the difficulty of finding highly qualified engineers in the civilian labour market in United Kingdom during war.

(*c*) The handling of Indian troops by Europeans entirely unaccustomed to the caste problems, peculiarities and easy offence at swearing or bad language called for constant watch on the part of V.C.O.s. and Officers, and it should be recorded that A.I.O.C. immediately acted favourably in the few cases where the Liaison Officer I.E.A.G. requested changes in civilian personnel for such reasons.

(*d*) It was extremely difficult to prevent splitting and mixing sections, or even companies, when works' sites demanded such varied trades allocations. This resulted in orders having to be accepted from strange N.C.O.s and V.C.O.s and was avoided wherever possible as it was very bad for military *esprit-de-corps* and discipline. After several years of military training it appeared incongruous to I.O.R.s and V.C.O.s alike that they should have to take orders from civilians, but it was finally possible to overcome these differences and Europeans and I.O.R.s were working together as a team who knew and understood each other.

(*e*) General military duties such as detailing officers for courts-martial or courts of inquiry, and the constant despatch of personnel on leave to India at short notice often resulted in complaints from A.I.O.C. that certain jobs were deficient of men or officers at a particular time.

5. Precautions for Troops' Health and Safety

In view of the presence of highly inflammable gas, fluids, etc., and of the large scale operations with heavy gear and machinery it was essential that all

possible safety precautions should be taken. The Abadan Refinery Safety Regulations are based upon the best industrial practice and the various Factory Acts, and it was necessary for these to be summarized in the Indian languages for the instruction of troops. Before commencing work in the Refinery each party was given a safety lecture by a member of the A.I.O.C. Safety Engineer's Dept. in Urdu, a pocket edition of safety hints was issued to every officer, and a full copy of the Refinery Safety Regulations was issued to each company H.Q.

In keeping with all other Departments of the A.I.O.C. a Group Safety Committee was formed, meetings were held monthly when each Unit raised any questions affecting the health or safety of their men. In this respect over-crowding of lorry transport, dirty transport trucks, bad insulation of welding set leads, etc. were all rectified. The minutes of the I.E.A.G. Safety Committee were submitted to the General Management Safety Committee and were incorporated in the minutes of that Committee with notes on the action that had been taken.

First Aid boxes were maintained in the Job Officer's office and records of all treatments were made. Accidents have been very few, and none have proved fatal. Arrangements were made for serious cases to be admitted direct to the A.I.O.C. Hospital to avoid delay. An M.I. Room with Dispenser functioned solely for I.E.A.G. personnel in the Refinery area, and Units detailed a Medical Orderly on a roster basis.

In view of the long working hours in the heat of summer, arrangements were made with the A.D.M.S. for an ambulance to be attached to the I.E.A.G. This was stationed at Liaison Office during all working hours, and was reserved solely for the use of heat stroke cases.

There was a fairly high incidence of eye cases when I.O.R.s commenced welding reinforcement, etc., but this was mainly due to the tendency for I.O.R.s to stand and watch the welders at work. Full protection for welders and welders mates was issued by A.I.O.C.

An outbreak of mumps necessitated the complete isolation of 1273 and 1275 Pioneer Coys. in February, but this prompt action on the part of the I.E.A.G. Medical Officer prevented the epidemic spreading to other personnel, although a considerable number of man-days was lost.

6. Welfare

Accommodation was constructed by R.E. Works services to Scale C, and fans were authorized for Canteens, Recreation tents, Officers' and V.C.O.s' tents, and Offices.

Sports areas were constructed, and A.I.O.C. Roads Dept. maintained a roster of rolling sports pitches during the whole year. Inter Unit sports were held and greatly appreciated.

Increased Y.M.C.A. facilities were provided, in addition to Unit Canteens, and a Swimming Bath was constructed adjacent to the I.E.A.G. Camps.

A.I.O.C. voted £1,000 to cover expenses in connexion with Welfare of the troops engaged upon their works, and paving was provided to the camps, furniture for messes, etc.

Leave to India commenced in the Spring of 1944 and greatly improved the morale of the troops, many of whom had been overseas for four years.

7. Security

All personnel entering the Refinery were controlled by Refinery passes issued as for civilian employees. Arrangements were made for A.I.O.C. for the taking of the large number of photographs required for these passes, and registers and nominal rolls were maintained by the Liaison Officer.

An I.E.A.G. Security Committee was formed, and all breaches of security raised by the Field Security Section (with Det. at Refinery Main Gate) were dealt with by this Committee. Close liaison with the anti-sabotage ring was maintained at all stages of the work.

8. Transport

The transport of I.E.A.G. personnel to and from the Refinery was the responsibility of the Transport Superintendent. Two railway trains each of fourteen wagons were run daily to two central points in the Refinery, while individual parties on isolated sites proceeded in a fleet of twenty-three 10-ton lorries.

Lorries and railway wagons were allotted by Units and detailed in I.E.A.G. Administrative Orders from time to time as the sites of construction works were changed.

Thirty M.T. Drivers of the I.E.A.G. Units were employed in their own trade as a pool of M.T. Drivers with a fleet of 3-ton Dodge tipper lorries delivering stores to sites.

9. Works Programme

At the peak period of construction I.E.A.G. personnel were manning thirty-seven different construction sites, and it would be impossible to give a fair word picture of the works involved ; the following summaries are, however, representative of the works upon which the I.E.A.G. has been employed and together with the accompanying photographs should enable one to judge the aid to the War effort that has been given during the fourteen months' life of the Indian Engineer Assistance Group.

(*a*) *Concrete Blockyard.*—This yard was responsible for the production of reinforced concrete ducts, channel covers, insulating slabs, and reinforced concrete roof trusses and purlins. It was under the control of one Sapper officer, and later controlled by a V.C.O., while employing some sixty sappers and one hundred pioneers.

(*b*) *No.* 7 *and* 8 *Re-run Units* (see Photo 1).—Large scale reinforced concrete construction with heavily reinforced concrete foundations each necessitating a pour of some 450 cu. yds. These plants are an essential part of the processing in the Cracking area of the Refinery. Executed under a Military Job Officer by Army Troops Coy. Sappers and tradesmen, assisted by an Engineer Bn. Company for the steel rigging and one hundred Pioneers.

(*c*) *No.* 21 *Washery.*—Steel framed building with reinforced concrete tank supports for lead lined acid washing tanks.

(*d*) *Nos.* 3 *and* 4 *Cooling Towers.*—Prefabricated timber Marley cooling towers constructed by thirty carpenters and sixty Sappers of an Engineer battalion company under a Military Job Officer. The electrical installation of the large extract fans, some 15 ft. diameter was carried out by electricians of the Army Troops Coy.

(*e*) *Nos.* 9, 10, 11, 12, 16, 20 *and* 21 *Boilers* (see Photo 2).—For the whole period, a company of the Engineer Bn. was engaged upon the erection of oil fired high pressure steam boilers. These boilers provide the steam for circulation round the processing plants of the Refinery, and were executed under the direction of Messrs. Balfour Beattie, Ltd., the sub-contractors to A.I.O.C. The erection of the 180-ft. chimney stacks was carried out by local contract, but all other works were executed by teams of one European fitter working with three Sappers. Very extensive reinforced concrete foundations were also required.

(*f*) *Air-conditioned Hospital Ward Block.*—A fifty-bed block for Labourers was constructed as part of the expansion to the hospital requirements by the

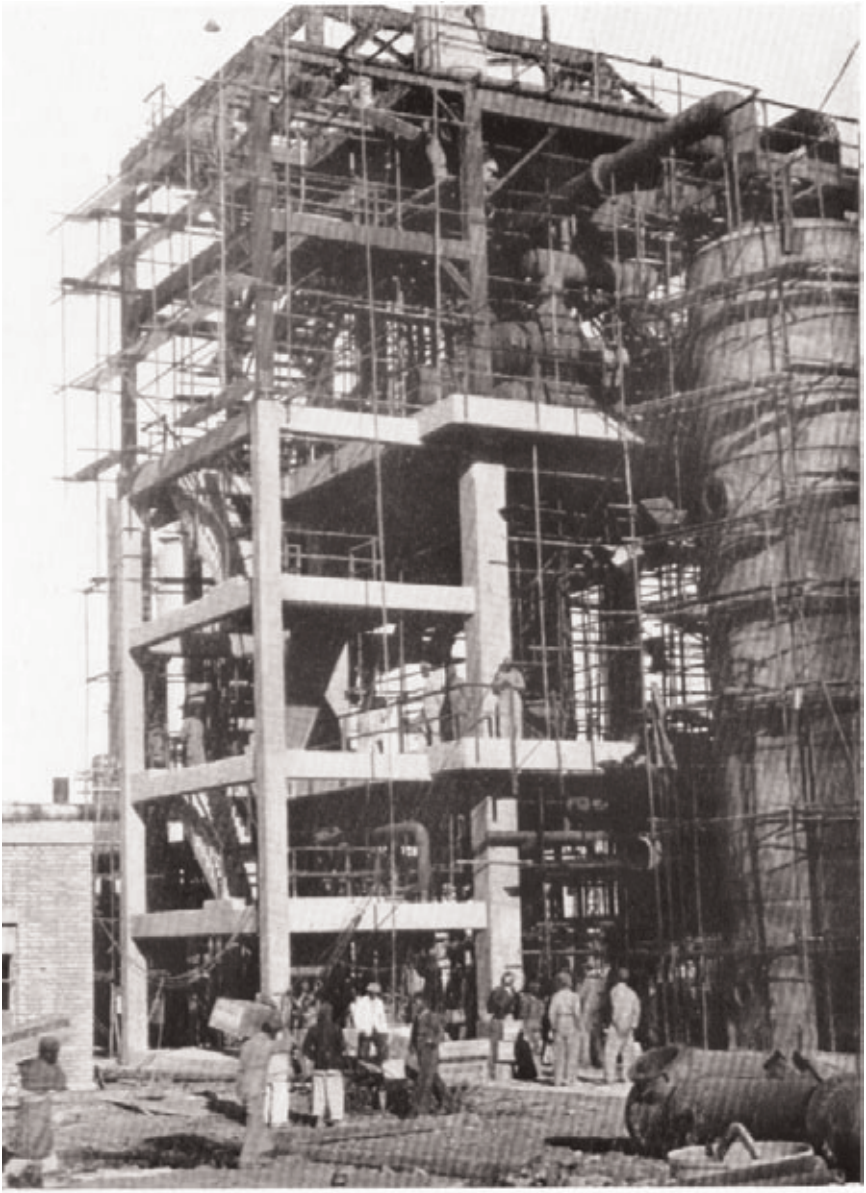


Photo. 1.—No. 7 Re-run Unit. 49 Army Tps. Coy.

Indian Engineer Assistance Group

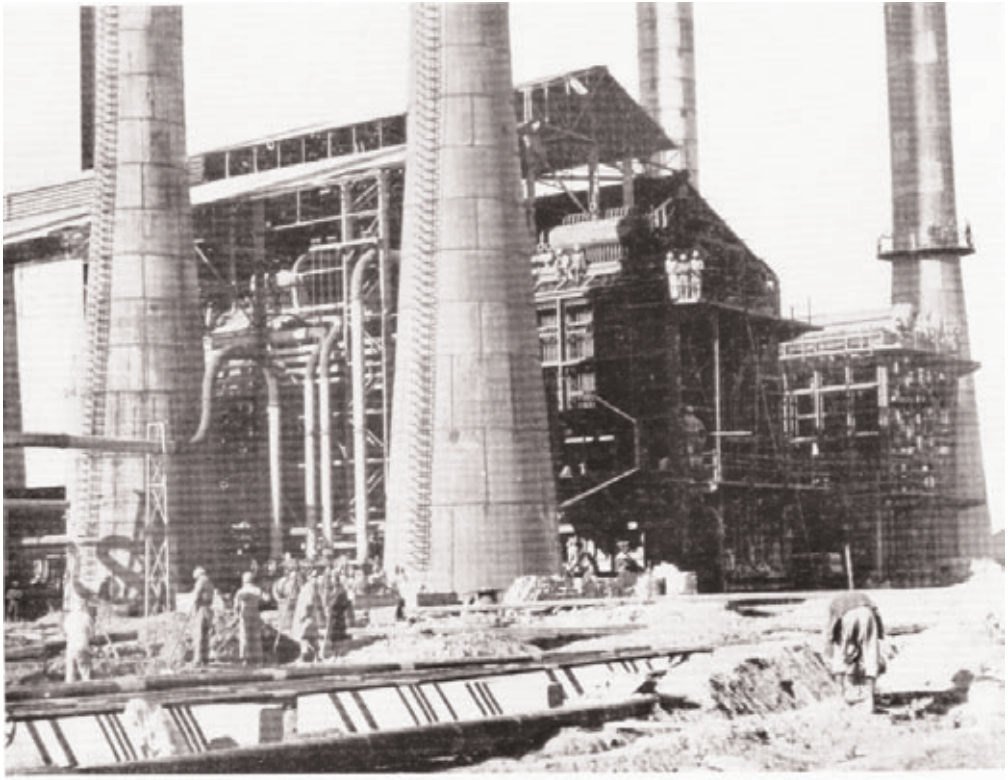


Photo. 2.—Nos. 9 and 10, 11 and 12 S.P.A. boilers. A Coy., 4 Engineer Bn.

Indian Engineer Assistance Group photo 2

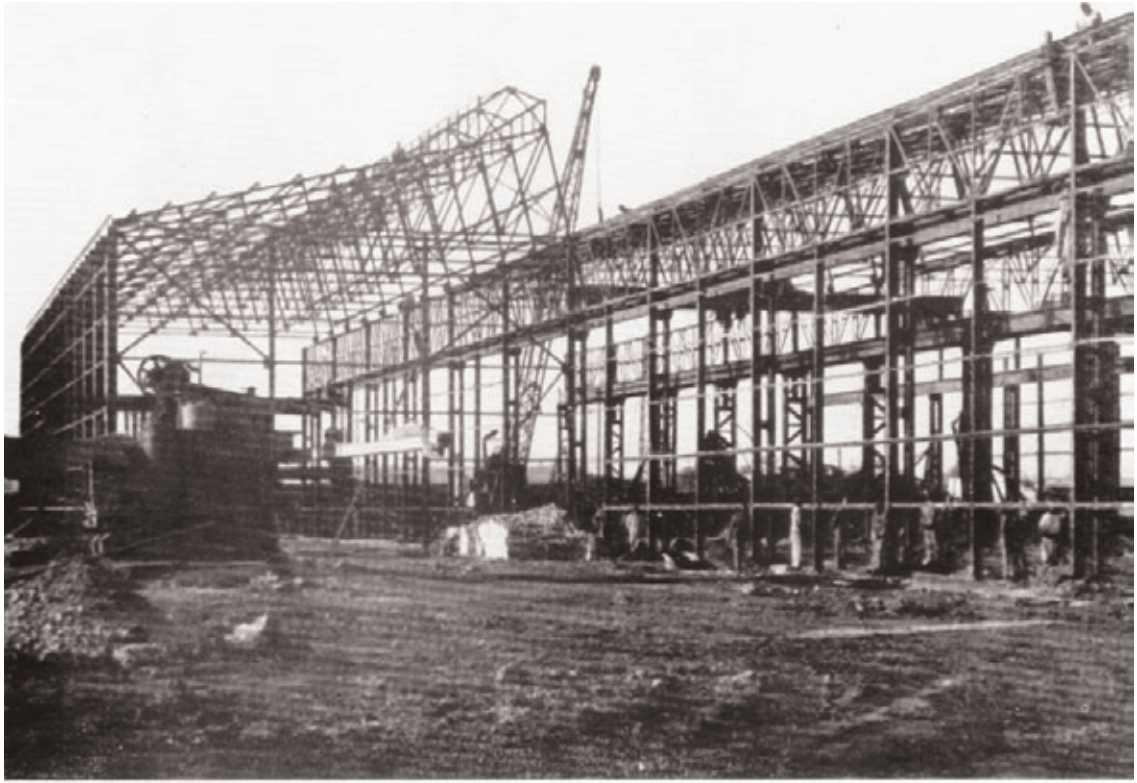


Photo. 3.—General view of main foundry.

Indian Engineer Assistance Group photo 3

Photo. 4.—Pipe line link-up. 1275 Pioneer Coy.

Indian Engineer Assistance Group photo 4

Artisan Works Coy., supplemented by Pioneer labour. This was carried out under the supervision of Messrs. Costain, Ltd. the sub-contractors for all outside and estate works, and comprised two twenty-five bed, air conditioned wards with all necessary annexes.

(*g*) *European Bachelor Accommodation.*—The Artisan Works Coy. was also engaged upon the construction of nine Bungalows for Bachelors, the additional accommodation being necessitated by the increased operating staff for the Refinery expansion.

(*h*) *Carpenters and Bar Bending yard.*—Forty carpenters and sixty Pioneers were engaged operating a central carpenters yard and reinforced bar bending yard where shuttering and reinforcement was prepared for all other construction sites of the Refinery.

(*i*) *Filtration and Ice Plants.*—One company of the Engineer Bn. was responsible for the entire construction of two 600,000 gal. filtration plants, one twenty-ton and two eight-ton ice plants as part of the services to the expansion scheme.

(*j*) *Locomotive Sheds and Main Foundry* (see Photo 3).—An enormous steel framed construction task, with reinforced concrete foundations and locomotive pits constructed by an Engineer Coy. with Pioneer labour.

(*k*) *No. 3 and 4 Aviation Re-run Unit.*—A processing plant, slightly smaller than No. 7 and 8 Re-runs, constructed of reinforced concrete framework, with steel framed superstructure and electric pump installations, carried out by Army Troops Coy. fitters.

(*l*) *Mobile Plant Workshops, Capital Stores and Cement Store.*—Large scale construction of steel framed shedding, with lattice girder gantries and overhead travelling crane erection. carried out by a company of the Engineer Battalion.

(*m*) *Generally.*—Other works have included a Power Sub-Station complete with plant installation carried out by Army Troops Coy. electricians ; four miles of brick-lined drainage nullah for Refinery effluent constructed by 150 Pioneers and sixty bricklayers of the Engineer Bn. ; considerable pipeline link-up work carried out by Pioneers under European fitters. (see Photo 4).

(*n*) *Sulphur Recovery Plant.*—Constructed by an Army Troops Coy section with Military Job Officer and carried out from site clearing to final test and operation.

(*o*) *Bench* 80 (*Preliminary Work and Foundations*).—Work on this job was commenced early in January and absorbed 250 Pioneers and eighty tradesmen of the Army Troops Coy. Three Sapper Military Job Officers were detailed, with two Pioneer Control officers, to work in close collaboration with the eleven civilian job officers of the A.I.O.C. The site was cleared for this new and largest processing unit in the Refinery. All foundations were prepared for pumps, primary and secondary towers and Vacuum tower (the largest vacuum in the world). Early stages of the steel erection were carried out, and the brickbuilt control room was constructed. The work was then taken over by the American Construction Engineers as it was desired to advance the completion date beyond the scope of the Indian personnel engaged.

Film shots of I.E.A.G. personnel working on this site were included in the film " Aid to Russia."

10. Conclusion

The unusual situations created by the operation of military labour under civilian organization were overcome through the co-operation of all concerned, with the result that the Indian Engineer Assistance Group has, without doubt, made a very essential contribution to the final victory.

RUSSIA IN ASIA

By Lieut.-Col. J. V. Davidson-Houston, M.B.E., R.E.

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Lecture given on 8th May, 1946. General Sir John Shea, G.C.B., K.C.M.G., D.S.O., in the Chair.

The Chairman, in introducing the lecturer, said: We welcome as our lecturer today Colonel Davidson-Houston, who has had much military experience not only as a regimental officer in the Royal Engineers but also as a staff officer in the Middle East and with the Special Force, Chindits, in the Burma campaign of 1944. He is an interpreter in Russian and Chinese and has had much Asiatic and Russian experience. In 1927–28 he was with the British troops in China, and toured Manchuria and North Korea as guest of the Japanese General Staff. In 1930–33 he was Military Observer during the operations in Manchuria, was attached to the Chinese forces, and travelled in North and Central China. He also paid two visits to Mongolia and three to Japan; and studied the battlefields of the Russo-Japanese war in Manchuria. In 1939–40 he was Assistant Military Attaché in Rumania, and visited the Russian frontier along the Dniester. In 1940 he visited Turkey, and then was with the Tenth Army in Iraq and commanded a liaison column in Kurdistan. He was liaison officer with the Russian Forces in Persia, visiting Azerbaijan and the Caspian shore. In 1942 he was Colonel on the General Staff of the Military Mission to Chungking; in 1943–44 he was attached to the Special Force in India and Burma, and in 1944 he again visited Chungking. As a result of all that experience you will agree that Colonel Davidson-Houston has sufficient authority to tell us a great deal about the subject on which he is going to speak.

I MUST preface my remarks by saying that my description of the history, geography and expansion of Russia will be somewhat sketchy, because time will not allow me to go into all the details, and the country to be covered is most extensive. In most instances the character and policy of a nation is determined by its physical environment, and nowhere is that more obvious than in the case of the Russians. On studying a map of the Soviet Union you will find that the country is hedged about by geographical circumstances. On the European frontier in the early days the Russians were constantly subjected to attacks by Finns, Scandinavians and other enemies from the north and west, and they were cut off from intercourse with Europe and from the influence of Rome. They therefore grew up quite differently from the rest of Europe, which probably partly accounts for their difference in outlook. Later in history the density of population in Europe and the strength of the armies of Central and Western European Powers made it impossible for the Russians to achieve any sort of expansion in those directions. In the north there was the extensive Arctic front covered by the frozen desert known as the *Tundra*, and the sea itself, frozen for a great part of the year. Eastwards, on the Pacific

seaboard, the Russians during their expansion have from time to time come up against, first, the Chinese Empire ; secondly, the Japanese ; and now American sea-power. Along the extended southern frontier, from the Pacific to the Black Sea, there is an expanse of desert, semi-desert and mountains.

In addition to this geographical enclosure the Russians have always felt themselves to be hedged about psychologically. In the early period of their development they were subject to constant attack by enemies—in fact, any foreign nation came to be regarded by the Russians as hostile. Even in the time of Ivan the Terrible (a contemporary of Queen Elizabeth), who tried to open foreign trade, merchants who arrived at Moscow were kept outside the city walls in the same way as the Chinese treated European merchants. The obvious reaction to that physical and psychological feeling of being hedged about is, as we saw to some extent in the case of Germany, an attempt to expand to the circumference of the ring and, having done that, to try to break out somewhere.

Expansion

The history of Russian expansion is often regarded as something recent because it is so much in the news at the moment, but it has in fact proceeded ever since the Russians became a nation. It was a case of the flag following trade, and to a great extent it was directed by geography. The map of Russia, both in Europe and Asia, shows a number of great rivers mostly flowing from north to south, or the other way, and connected by the valleys of their tributaries, themselves in many cases navigable rivers. The Russians tended to follow those tributaries of the great rivers, and that gave direction to their expansion. Every now and then they used to come up against a check, and whenever that happened they stopped and began to look somewhere else. Throughout Russian history there has been expansion followed by a check somewhere, and then a change of direction.

I believe the first event in Russian expansion was in 1482, when Ivan III was proclaimed Tsar of all the Russias and for the first time united the various small principalities. He was the Prince of Muscovy, with Moscow as his capital. From that time until Peter the Great, Moscow remained the capital of Russia. As soon as the Russians consolidated themselves into a nation they began to push out the Tartars and to occupy the Tartar kingdom of Kazan to the east, and in 1558 they entered Siberia. Expansion into Siberia was very natural. The Ural Mountains are no physical barrier and Siberia is similar to Russia, a country of vast forests and steppe, through which flow great rivers with tributaries affording means of movement. The Russians also knew that there were furs, gold and spare land to be had in Siberia. The population was primitive and sparse, so the Russians expanded quite naturally eastward across Siberia. They expanded so quickly that less than one hundred years later, 1638, they reached the Pacific. Here for the first time they came up against a Power, the Chinese Empire (then ruled by the Manchus and at its heyday). These objected strongly to the presence of the Russians. There was a good deal of sporadic fighting, and eventually an agreement was concluded in 1689, the Treaty of Nerchinsk, by which the Russians agreed to halt on the line of the Argun River, which flows north and south some hundreds of miles west of the Pacific. The Manchus claimed all the country to the east of that, and the Russians had to be content with the territory to the west. This merely caused a change of direction : the Russians moved north-eastwards into the country of the Samoyeds and occupied Kamchatka ; they also reached the Behring Sea and crossed into Alaska,

which remained a Russian colony until 1867, when the Americans induced the Russians to sell it for a modest sum just before the discovery of gold there.

During this time, although their military expansion into Chinese territory stopped, Russia's political expansion continued, and by means of embassies, peaceful penetration and exchange of merchandise, the Russians during the next century established themselves very well in China, and there was actually a Russian Mission in Peking long before any of the other European Powers were admitted.

The next direction in which the Russians began to expand was in the Caucasus. In the time of Peter the Great certain explorations and movements were made into the country between the Black Sea and the Caspian, which at that time contained territory belonging to the Persian and Turkish Empires. There was a certain amount to attract the Russians there: the valleys were fertile and there were minerals to be mined. This expansion continued slowly for a long time and was accompanied by campaigns against both the Turks and Persians, which were not consummated until after the Crimean War. The expansion into the Caucasus was a reaction to the failure of the Russians to reach Constantinople by the Black Sea. The British and the French had checked Russian ambitions in the Straits, and as a kind of offset they began to get at Turkey by the back door, for there we could not interfere.

Another direction in which expansion began in the nineteenth century on a big scale was into Turkestan, east of the Caspian. The territories there were under Persian and Chinese suzerainties. The economic attractions were cotton, minerals, and the fact that through that area east of the Caspian ran the old trade routes between China, the Far East generally, Central Asia and the West. At this time there were two Khanates, Khiva and Bukhara, where the Russians found it necessary to assert themselves owing to the fact that their communications and caravans were being constantly raided by warlike tribes. In that part of Asia the Russians have been compelled at various times to subdue lawless peoples which raided their caravans and their peaceful settlers, and having subdued those tribes and made them law-abiding they had to protect them against other tribes which raided them. Thus one thing led to another, resulting in considerable expansion in and eventual Russification of most of Turkestan.

Later in the nineteenth century, having overrun Turkestan, the Russians found themselves up against the borders of Afghanistan and began to experience a check from that direction. Their appearance on the Afghan frontier naturally attracted the attention of the Indian Government. That is recent history. The Russians did, in fact, pause on the Afghan border at the end of the nineteenth century. In the meantime the Chinese Government had grown very weak, and the Russians took advantage of that to push on again in Eastern Siberia; they reached the Pacific coast and thus brought their eastern march to the sea.

In 1898 they leased, from China, Port Arthur and the territory where they built the entrepot of Dalny, the first ice-free ports the Russians had managed to acquire. Between 1891 and 1903 they completed the Trans-Siberian railway, joining Vladivostok to European Russia. That railway had two branches in the Far East, one of which went round the Manchurian border entirely in Russian territory; the other took a short cut straight through Chinese territory. That afforded the Russians a stake in Manchuria itself; it gave them communications to protect and country to exploit by means of the railway. They thus began to take an interest in Manchuria. They developed a branch of the railway south to Port

Arthur, where they had established a naval base. After the completion of this railway the Russians experienced another setback because they came up against the Japanese, and the Russo-Japanese War checked their ambitions in Manchuria. The Revolution followed shortly afterwards, which made it difficult for the Russians to achieve any further expansion. There was thus a period of stalemate, but to compensate for this lack of external expansion in the Far East and Europe the Russians began to busy themselves about the central part of their frontier, particularly in Mongolia and Sinkiang, where they were not up against any strong opposition. As they extended their sphere of influence there they also began to develop communications along the long land frontier: they completed the Turkestan-Siberian railway, joining the Trans-Siberian to the Turkestan systems; they established a line of air bases parallel to the frontier and air communication along the whole of the southern border. It is interesting to note that up to the present time, in spite of all this expansion, the total population of Soviet Asia is reckoned to be only 30,000,000 out of a total population for the whole empire of 190,000,000, so that there is no pressure of population to account for this phenomenon.

Motive Forces

With the foregoing in mind, we must ask what were the motive forces behind this expansion. History shows that they can be, broadly, divided into three; desire for protection or security, economics, and out-and-out imperialism.

The security aspect can be further sub-divided: the first and most important sub-division being the strategic one. From the defensive point of view the Russians wished to deprive any potential enemy of bases from which to launch an attack on their territory, and themselves to occupy bases convenient for attacking an enemy's territory. At the present time many of the resources of Soviet Russia—such as oil, coal, iron and the newly developed industrial areas—are near the frontier, and it is therefore desirable for them to control the territory beyond the frontier so as to make it difficult for an enemy to threaten these resources. In addition, the Trans-Siberian railway and the Turkestan railway run near the border practically the whole of their way. In modern times the development of air attack and long-range weapons, such as rockets, makes it desirable to control territory further and further away from the centres of industry and population. In fact, there is no end to the range which one can claim to bring under one's control in these circumstances.

A second method of protection is to induce one's neighbours to be friendly or to be puppets, and the Russians have adopted those principles. Where they have not actually occupied a country with their armies they have encouraged the setting up of Communist Party governments or frightened the existing government into being friendly.

The third method of protection has been ethnic. Practically the whole way along the Russian land frontier the population on each side are of the same stock, and the Russian is a good assimilator. Since he first started to expand he has never had any racial prejudices or colour bar; he has always mixed with the people—Turkoman, Tartar or whatever they might be—and he has been very successful in Russification, so that the population of the Soviet Union is far more homogeneous than that of the British Empire. This assimilation has a certain value offensively and defensively; if people on the other side of the frontier can be brought to think in the same

way as those on the Soviet side it affords a zone of influence—as, for instance, in Persian Azerbaijan; it also encourages attempts to control the territories beyond the frontier, so that the Soviet people will not be influenced by their kinsmen on the far side.

Then there is the system of economic zones. When the Russians trade with a neighbouring country they usually try so to dominate that trade that it is conducted to their advantage. There is also the question of protection of trade routes. As I have said, the Russians in their earlier days often had to subdue tribes who raided their trade routes or nations who threatened them, and, having pacified these, they had to protect them by dominating somebody else. That is not so important at the present time. The chief economic interest the Russians now have is to dominate or control the trade between their country and neighbouring countries.

Another economic desire is to obtain ice-free ports. Geography has given Russia ports which are closed part of the year by ice, and she is always trying to find outlets to warm seas which will be open all the year round without the use of ice-breakers.

Lastly, there is simple imperialism, the idea of expanding wherever the soil is propitious. That went on under the Tsars, and it appears to be going on today. It is partly a question of prestige. The Soviet Union does not want to occupy an area smaller than the Tsar's Empire, and in late years has turned its attention to territories lost during the Revolution.

The Asian March

Let us then look along the Asiatic frontier and see what is going on there, what expansion is taking place at the moment, and what is the likelihood of attempts at future expansion.

Manchuria.—The present frontier is the Amur River—an ethnic frontier, not an economic one. Rivers are nearly always bad frontiers, because the economy of a country builds up on both sides of the river. But this is an ethnic frontier in that the population to the north is overwhelmingly Russian owing to colonization; while that to the south is overwhelmingly Chinese, also owing to the colonization which took place during the nineteenth century. In this case the Russians cannot claim to have fellow-countrymen on the far side. On the other hand, the Amur River is a great trade route, navigable by steamers, and is not a good frontier from that point of view; both banks really belong to the same unit. Russian interests in Manchuria are both economic and strategic. There are coal-mines and unexploited minerals; there is a tremendous soya-bean output; and there are hides to be had from the considerable stock of cattle there. Manchuria also offers a number of ice-free ports—Port Arthur, Newchwang and Dairen in the south; Vladivostok, although on the same latitude as Madrid, is only kept open by ice-breakers in the winter. The Russians have also communications to defend; there is a railway running through Manchuria which they wish to be sure is free from threat by any other Pacific Power. We have seen, during the last few months, that the Russian troops which entered Manchuria at the end of the Japanese war have been induced to withdraw, but as the Central Chinese Government forces come into Manchuria to take over they find themselves opposed by Chinese Communist armies who seem to be taking the place of the Russians.

Korea.—To the south of Manchuria is Korea. The frontier between Korea and the Soviet Union is a short one, the estuary of the Tumen River. The Russians are obviously interested in Korea because it would round off their eastern seaboard and make it difficult for any other Pacific


SIBERIA
RUSSIA
TANNU-TUVA
MANCHURIA
MONGOLIA
KOREA
JAPAN
TURKEY
SOVIET TURKISTAN
SINKIANG
CHINA
PERSIA
AFGHANISTAN
TIBET
INDIA
RUSSIA in ASIA
and ADJACENT COUNTRIES

Power directly to threaten Vladivostok or Manchuria from that side, and it forms a right flank to their Far Eastern possessions. Again, Korea has some well-developed warm-water ports, particularly Seishin and Rashin, which the Japanese were completing just before the war. Again, Korea has never in modern times governed herself ; she was first under Chinese and next under Jap suzerainty, and has not since set up any satisfactory government of her own. The country is occupied by Russian forces in the north and American forces in the south. The Russians in their zone have been encouraging the Korean Communist Party, which I should say is much better organized than any party in the American zone and may eventually, when the Russians and the Americans remove their troops, achieve considerable influence in the polity of Korea.

Outer Mongolia.—West of Manchuria we come to Mongolia, a neighbour with a hilly but not difficult frontier, including the Gobi, which is desert in parts but elsewhere supports considerable herds of cattle, sheep and ponies. There the Russians possess the advantage of having the Buryat Soviet Republic just north of the frontier, where the population is of similar stock to that in Mongolia itself. Communications are well developed ; there is a railway running from the Trans-Siberian line to Urga, now called Ulan Bator Khoto, the capital of Outer Mongolia. Russian interests in Outer Mongolia are partly economic ; there is a well-developed trade route which is motorable right across Outer Mongolia into North China ; there is also considerable pasture for sheep and cattle ; there are many unexploited minerals. Another attraction is the fact that Outer Mongolia affords a kind of cushion to Siberia; it is a protective zone to the Trans-Siberian railway in case any hostile Power tried to operate from North China. Mongolia has always been technically under Chinese suzerainty, but the Russians had considerable interests there long before this present century began, and during the Revolution they were afforded an opportunity to intervene in the country because a White Russian force had entered Outer Mongolia and occupied Urga. The Red Army came in, destroyed the White Army, set up the " Mongolian People's Republic " in 1921, and the country was organized on Soviet lines with Russian troops to see that it remained so. It is now an independent state, with strong pro-Russian leanings. It is not possible, however, to get into Outer Mongolia from any direction except under Moscow's sponsorship. I have tried, and have been told, " You can do it only by applying to Moscow," well knowing that such an application would be met by the argument that Mongolia is an independent country and that reference must be made to Ulan Bator, where Great Britain is not represented. Russian influence over Outer Mongolia is going to have repercussions on Inner Mongolia, which has hitherto been much more under Chinese influence than Outer Mongolia. Now that Chinese Communist troops in North China have set themselves up in Inner Mongolia there may be a pro-Russian sphere of influence right down to the Great Wall on the the borders of China proper.

Tannu Tuva.—At the north-west corner of Outer Mongolia there is an interesting little country called Tannu Tuva, of which most of us had not heard until recently ; it is very mountainous and about one-third of the size of Germany, with a small population. Its only link with the outer world—that is, the U.S.S.R.—is either by air or along the valley of the Yenisei, a river running towards the Arctic. The population is Urian-Khai Mongol, akin to the Buryats of the Soviet Union. The chief Russian interests in the country are the considerable livestock grazed there and the fact that it stands in a central position between Mongolia, Chinese Turkestan

and Soviet Asia. It was set up as an independent " republic " under similar conditions to Outer Mongolia, and even issued its own stamps. But quite recently it has become a province of the Soviet Union, apparently at its own request.

Sinkiang.—Further west we come to Sinkiang (or Chinese Turkestan). The frontier is mountainous and the country in the north of Sinkiang is quasi-desert, but communications with Russian territory have been improved considerably by means of the Turk-Sib railway and the road across the frontier to Urumchi the capital. The distance from Sinkiang to the trade centres of China is so much greater than to Siberia or to Russian Turkestan that trade naturally tends to flow to and from the U.S.S.R. rather than China. Sinkiang has therefore long been subject to considerable Russian influence. The population of the country is mainly Turkoman, similar in race to the people of Russian Turkestan ; there are also inhabitants of partly Chinese origin called Tungans, Periodically there have been Moslem risings against Chinese rule, of which the Russians have been able to take advantage by sending in troops and occupying parts of the country. During these operations they succeeded in detaching a piece of Chinese Turkestan in the neighbourhood of Lakes Balkhash and Issik Kul, which during the last century was made part of the Russian Empire ; but there is no ethnic frontier and the Turkoman-Moslem population flows over both sides of the political boundary. The chief interests, besides trade, are considerable resources of minerals not yet fully exploited but which may possibly yield results if the Russians are able to develop them. Russian influence in Sinkiang has an inevitable effect on India because there is a trade route over the passes into Chitral, where recently it has been reported that Russian piece-goods are to be found in the bazaars. Indian merchants in Sinkiang have been suffering as a result of the increase of Russian predominance over the last twenty years or so, so that we could not be indifferent in India to Russian ascendancy in Sinkiang.

Afghanistan.—Further west again we come to Afghanistan, the frontier of which is partly the River Oxus (again not a very good boundary) and partly a line of mountains. It is not the ethnic frontier, because in Northern Afghanistan there are Tajiks and Uzbeks, who are kin to the inhabitants of Soviet Tajikistan and Uzbekistan. The ethnic line is the Hindu Kush, a range of mountains running north-east to south-west, south of which the people are Pathans with no ethnic connection with the Soviet Union. Russian interests in Afghanistan until recently have been entirely strategic, because occupation of Afghanistan puts them on the frontier of India, and, on the other hand, they affected to believe that the British had ideas of threatening their territory through that country. There are now signs that the minerals of Afghanistan, particularly oil, are interesting the Russians. They have developed communications into Afghanistan by two main routes : one is from the region of Tashkent on the Turk-Sib railway to Termez on the Afghan border, from where there is a road through Balkh to Kabul and so into India ; the other route is from Merv, also on the Turk-Sib railway, to Herat. Herat is a centre of communications with Persia, Baluchistan and India. One can thus see that if we withdraw our forces from India and cease to direct Indian policy we should not be able to help Afghanistan, and Afghanistan by herself is unable to offer effective opposition to pressure from Russia. It is thus most important that under present conditions in India the Foreign Office should take over from Delhi control of our relations with Afghanistan.

Persia.—Perhaps the most interesting country at the present time is

Persia, the frontier of which has been moved back and back for a number of generations. Much of the territory in the Soviet Union was part of the Persian Empire. The frontier at the moment follows the Araxes River (west of the Caspian), the southern shore of that sea, and roughly the line of the Atrek River to the east of the Caspian. The population in the north of Persia is similar to the Soviet inhabitants in the south of the Union. On the west the Armenians lie opposite the Armenian Soviet Republic, the Azerbaijani are neighbours to the Azerbaijan Soviet Republic, and the Turkomans live next to the Turkmenistan Republic, which makes it easier for the Russians to assert their influence in North Persia. The Persian proper does not come up to the frontier ; his home is in Middle and Southern Persia. The chief Russian interests in the country, besides its races, are oil and grain. Moscow has recently succeeded in achieving an agreement regarding North Persian oil by putting pressure on the Persians. The oil-fields of the Caucasus are believed not to be yielding as much as they did and the Russians therefore want new sources of oil in the same part of the world. Most of the grain of Persia is grown in the north ; if, therefore, they were able to assert themselves in North Persia the Russians could put pressure on the whole country. They would like to control the southern Caspian shore to give them east-west communications and avoid sea journeys across the Caspian. Again there is the ever-present lure of warm-water harbours. In South Persia there is the newly developed port of Bandarshahpur, joined with the Caspian by the Trans-Persian railway, both of which were completed shortly before the late war. If, therefore, the Russians were able to secure special rights in ports on the Persian Gulf they would find the Trans-Persian railway available for their use. Among the methods they are adopting at the moment is that of seeking the sympathy of the border races, and I note that they have been encouraging the establishment of a Kurdish autonomous government, although there are *no* Kurds in the Soviet Union itself. The significance of this is that there are Kurds in Asia Minor and in Iraq. Therefore the establishment of any sort of Kurdish government in Persia would have an effect in Northern Iraq and in Eastern Turkey. Again, there is a political party in Persia called *Tudeh*, which appears to be organized rather like the Communist Party. Its point of view has openly been expressed as anti-British and pro-Russian. It is not a racial organization : it is a general political party which has a certain amount of influence in all parts of Persia. The withdrawal of our forces has left Russia with relatively greater influence, and the Anglo-Iranian oil interests in the south are without any protection other than international goodwill. It is significant that the company is having labour troubles fomented by the Tudeh Party.

Turkey.—The last country on our tour is Turkey, whose frontier with Russia is the Caucasus, always unstable because the people in the area are neither Turks nor Russians. The Russians have been advancing in that area for generations ; in 1878 they occupied Kars and Erzerum and in 1886 they occupied Batum on the Black Sea. Recently the Russians have been putting considerable pressure on Turkey ; an article in a Russian newspaper even argued that certain areas should be given to Russia because they are ethnically Georgian, and, although the Georgians are not Russians, there is a considerable Georgian population in the Soviet Union. The object all the while has been to obtain a warm-water port. Constantinople and the Straits lead to the Mediterranean and the sea lanes of the world. We have heard of the demands for influence in Tripoli and the argument over the port of Trieste. If the Jugoslavs controlled Trieste, their friendship with Moscow would give the Russians facilities in the Medi-

terranean. Pressure has also been exerted in Bulgaria, where the concentration of Russian troops caused a certain amount of alarm to the Turks in Thrace ; again, any Kurdish national movement is bound to have repercussions on Turkey's eastern territory.

Conclusions

I suggest that the Russian land frontier in Asia has consistently shown itself to be unstable and that the expansion of Russia can be attributed to three motive forces: first, an exaggerated desire for security against a possible enemy ; secondly, the tendency to assimilate neighbouring peoples and, having assimilated them, to take an interest in any other cognate peoples across the frontier ; thirdly, economic and political imperialism, one of the strongest factors in which is the desire for ports on the open sea lanes of the world. There is another factor which I think needs further investigation, and that is the possible desire to keep considerable parts of the Russian armies abroad for a few years rather than bring them home and make recovery more difficult.

I think we can conclude that the expansion does not arise from any need of living space ; the Russians have plenty of that. Their economic needs appear to be somewhat exaggerated. Perhaps we can yield that in Persia the desire for oil is natural because the Persian oilfields are in the same area as the ageing fields worked by the Russians and would be most convenient to the Soviet Union, as would the resources of other minerals not yet thoroughly exploited.

These factors have led to continuous encroachment, which will continue so long as the motive forces remain and there is no effective opposition. It must be remembered that all these countries from the Pacific to the Black Sea are weak, and have depended in recent years on the backing of Great Powers to prevent any encroachment on their territory. Unless the Great Powers take an interest not only in what happens near home but also in the whole of Asia, the Russian expansion is likely to continue. One of the main difficulties arises from *faits accomplis*. Once an area is occupied, or a sphere of influence is established, it is much more difficult to take steps than if something had been done to prevent or foresee the event. Who is going to do anything about Tannu Tuva now, even if he wished to ?

Discussion

During the subsequent discussion, three points of interest emerged :—

Manchuria.—Although for many generations this has been to all intents and purposes a Chinese country, it has always held a quasi-feudal status, and has not been directly subordinate to the Chinese Central Government. There is no doubt that if the Chinese were left to themselves, the Manchurian provinces would come to be treated as other parts of China ; hence China's resentment at the Allies' yielding to Russia's insistence on her special rights there.

Persia.—Russia's interest in Persian oil does not necessarily imply that the Caucasian sources are exhausted ; it may be due to the need for further sources to match her industrial expansion, and to the fear that other Powers might secure concessions in North Persia.

Turkey.—The disputed border territories (Kars, Erzerum, etc.) were taken by Russia from the Ottoman Empire in 1878, but were recovered by Turkey during Russia's weakness in 1921. The inhabitants are neither Turkish nor Russian, so that this frontier will remain unstable until a spirit of accommodation animates these two Powers.

AIR MINISTRY COMMITTEE

By "J.C.T.W."

Well, here I am. Right place, right date, right time and fully briefed. I am in good time too, as the other members of the Committee are only just beginning to arrive. . . .

Hello, there's another bloke I don't know. That's three here this morning who haven't attended the earlier meetings . . . "standing in" for their Big Boys I expect. Same as I am . . . why, darn it, there's two more "stand ins" just come. They can't be going to deal with much that's important today at any rate. . . . Gosh, I don't know a soul in the room! . . .

Have I come on the wrong date? No, I have checked it on the printed slip they gave me in the office. Time and date are right, anyway. I suppose I'm up in the wrong room. It is easy enough in this huge barrack. I'll slink out furtively and read the number on the door. Gosh . . . I'm in the right room too. What the hell Committee *is* this, I wonder! It seems to be composed of nothing but obviously distinguished scientists. . . . In fact my uniform is more than conspicuous and I am beginning to feel rather brutal and licentious looking.

I'll ask someone. No . . . it's too late. The Chairman has called the Meeting to order and we're off! I am sitting down now looking wise. I've just been asked whom I represent. I daren't tell them the truth or I shall get manhandled, like a visitor in the Stock Exchange building. I say "War Office" firmly and think I've got away with it. Anyway, no one's hit me yet. . . . A white-haired card is now reporting to the Committee. . . . He's full of formulae and figures and it must all be good stuff because everyone's writing it down with little grunts of satisfaction. I do the same and try to look very absorbed. Someone's looking hard at me. I must have grunted too loud. Overdoing it as usual. I must be more careful. . . .

This Meeting has gone on for hours and the strain of looking intelligent or keeping awake and, if possible, both, is beginning to tell on me. . . . Good, it's nearly over . . . the Chairman is asking for final comments. Heavens, he's asking *me*. I reply very firmly, "No, not at *this* stage," and I think I've got away with it again. . . .

Now what in hell *was* that Committee?

As a matter of fact I *had* some final comments. I have just written them. You've just read them.

REPORT OF CLEARANCE OF RIVER WESER BETWEEN ACHIM AND OISTE

By Lieut. J. Thomson, R.E.

THE problem of clearing navigable channels of the River Weser, between Achim and Oiste, involved two major tasks. Two road bridges and one railway bridge crossed the river between Gr. Hutbergen and the Bremen enclave. Of these, only the railway bridge remained intact at the cessation of hostilities. The two road bridges were each steel bow-string girder structures.

The bridge at Hutbergen was a comparatively new structure and consisted of a very large girder, strengthened to cover its span of 250 ft. by an upper boom and verticals. The upper boom and verticals were added when a bridge of higher classification was required. There was no diagonal bracing, and the structure had a peculiarly light and elegant appearance. In spite of this it weighed some 550 tons.

The second bridge crossed at Usen and this structure was an old railway bridge, originally built elsewhere. In 1927 it was removed intact and re-erected on the road crossing at Usen. This was also a bow-string, but it had diagonal bracing. The finished bridge had a much heavier appearance than the one at Hutbergen and proved throughout a much more clumsy and temperamental specimen than the other. It had a clear span of about 190 ft. and weighed some 500 tons.

Both bridges were on major second class roads ; laterals between the Nienburg–Bremen road and the Nienburg–Hamburg road. The river was, at one stage, a holding line for the retreating German forces and the two bridges were of such importance that they were demolished. The demolition was thoroughly effective in each case and the spans were left partially immersed in the river at right angles to the current. The roadway in both cases was completely submerged. Whether to remove them or reconstruct them had not been decided, but the most important task was to clear the Weser for river traffic at the earliest moment. Also, the flood banks were constructed to cope with the highest known floods only, and had no great safety margin. It was, therefore, obvious that such obstruction would catch floating ice and create further serious danger of extensive flooding.

There was, apparently, some discussion at a " higher level " as to the most economical method of clearance. Three alternatives were considered. Firstly, the bridges might have been raised in situ on temporary piers and new members inserted to complete the span. Secondly, the bridges could have been cut up and removed in small pieces, and thirdly, the bridges might be floated and removed complete. The Germans, I think, favoured the first, but it was late summer before they had organized their resources and they were much too late to try until the following summer. The second would have been a lengthy and tedious task at the best because it would involve much under-water work, The third, at first sight probably the most difficult, was adopted.

The project was one which naturally fell into a series of clearly defined jobs, separated by considerations of river levels and weather. The whole was to be carried out by the German Wasserstrasse with consultants from Royal Engineer units, who were to organize and supervise all work. The

first stages were supervised by 55 Fd. Coy. R.E. who, unfortunately, had to hand over in a hurry and left only a very brief verbal report of what had happened.

During the summer months, with the river at low level, the ragged ends of both bridges were cut off in order to leave room to swing the structures between the piers. Two teams of divers were used at first ; one of German experts, and the other from an R.A.S.C. motor boat company. They were both equipped with underwater cutting apparatus. At low level, the speed of the current was 80 cm. per sec. and it was found that the Army team could work quite easily and efficiently in this current, while the German team was much more temperamental and frequently made excuses for not going down. The lack of an expert in an R.E. Field company was felt rather badly at times. Once the twisted extremities had been removed, the first task subdivided itself again. The bridge had to be floated, and the ragged ends cut into pieces sufficiently small to be taken from the river up the bank above flood level. Three A.Vs.R.E. (Churchill tanks) from 11 Fd. Coy. R.E. were made available for this subsidiary task, and from then on they were used, whenever weather conditions permitted, to tow out pieces from the river bed. These pieces weighed anything up to 5 tons each, but they did not interfere with the navigable channel and constituted no danger for flooding as they all lay in shallow water and were nearly all flat members. The main troubles arose from mud forming on the river banks, preventing the tanks from getting a good grip, poor S.W.R., and an inadequate supply of Bulldog clips, shackles, etc. Worst of all, as usual, was the weather. It soon became impossible to work under water owing to the very low temperature.

Meanwhile 55 Fd. Coy. R.E. had obtained four river barges of approximate capacity 1,000 tons each. Their laden draft was between 8 and 9ft. At the Hutbergen site, the barges *Anita* and *Ingrid* were to be used. By this time the bridges were firmly set in the bed of the river and a large quantity of silt had settled on the deck of the bridge, which was complete even to the granite sets. The distribution of the loading had to be judged and the barges positioned so that when the bridge was eventually suspended, the whole floating structure would be reasonably well-trimmed. This was not very difficult to estimate, as both structures were approximately symmetrical on both axes. The next stage was to flood the barges, sinking them to their minimum freeboard. Girders then had to be constructed spanning between the two barges and interlacing the uprights of the bridges.

At Hutbergen this was easy due to the absence of diagonal bracing, and it was possible to insert four double-double Bailey and two quadruple-single trusses. At Usen, there was only room for six triple-single trusses, so three large civilian plate girders were added. The plate girders visibly deflected under the load. The weight had then to be transferred from the bridge structure via the Bailey trusses to the barges. Bailey transoms were placed on edge along the top chords of the trusses, and on top of these piers of 12 in. x 12 in. baulks were built, wedged at the top under the upper boom. Where this height was too great, brackets were welded to the verticals and they took the strain. The packing was strapped with S.W.R. strops and fixed with 15 in. dogs. This completed, the barges were hopefully pumped dry, and the first " lift " on the bridge was taken. It was necessary to use small charges of explosives in the surrounding mud to break down the suction effect.

The effective lift was very small indeed, but it had proved that the bridge would float—a point on which there had so far been some doubt. The underside of the bridge was still a long way below the bottom of the barges.

It was also obvious that the quantity of silt lying on the deck was having a considerable effect and would have to be removed. The fact that it was still submerged prevented the obvious solution of a large gang of Germans with shovels, but the river itself solved the problem in a most practical way by swinging the structure round until the current was running down the length of the roadway which soon scoured the deck clean, and a further few valuable inches of lift were obtained. The clearance between the river bottom and that of the structure was, however, still very small, so the bridge was once again run aground on a sand bank and the barges were again flooded. More packing was inserted and a further lift was obtained. This process continued until sufficient clearance had been obtained to clear the shallowest stretch of the river.

During this time, the same operation was going on at Usen with exactly similar results. In this case, the barges used were the *Jupiter* and the *Marie*.

It was in the middle of these latter stages of raising the bridges that 276 (H) Fd. Coy. R.E., assumed all responsibility for the operation on the departure of 55 Fd. Coy. R.E. My platoon (No 3) was to complete the task. Once we had raised the bottom of the bridge to the same level as the bottom of the barges, there was little else could be done except to continue with the clearance of the smaller pieces with the assistance of the Churchills. However, it gave us the necessary opportunity for making the arrangements for the next stages. The I.W.T. (Inland Water Transport) were anxious that the barges should be released as soon as possible, so a plan had to be made to drop the structures somewhere out of the way. A suitable hard was located by the Wasserstrasse on the south bank of the river at Baden. On checking, I confirmed it as suitable. Opposite this, on the north bank, there was a convenient mooring in the mouth of a new canal whose construction had been abandoned during the war, but already of sufficient depth and width to harbour both structures safely until suitable flood conditions existed to run the structures aground well clear of the normal channel. A few river craft were sheltering there pending the arrival of ice-floes.

From then onwards, a careful watch was maintained on flooding forecasts and river levels. The minimum depth of water required was worked out in conjunction with the *Wasserstrasseampt* from their river charts, Eventually, about 15th November, 1945, the water level almost reached the required minimum, but turned before quite reaching it—our first disappointment. However, it was too near to let the chance slip by and we decided to try, because there was considerable apprehension about ice-floes as the winter was approaching. The first attempt was made at Usen where there was only about a mile upstream to travel. That day, the tugs *Oker*, *Bramburg* and *Reinhardt*, assisted by up to five powerful river barges, were used before we made sufficient headway to enable us to cast off from the anchorages. This was not done until the structure was well and truly under way. When about half the length of the structure had passed the old piers, it came slowly to a stop, without any noise at all, and remained fast. Additional barges were co-opted and made to push at the tail, but still without effect. It was then dropped back downstream and several more runs were taken, as far as possible choosing new parts of the navigable channel each time in order to make sure we were not missing the clear by a few feet. Once, the projecting Bailey trusses came within inches of fouling the south pier. The results were the same, and as the water level was falling, we had to desist. One thing, however, had been proved by the effort—that we had the power to carry out the task, given sufficient depth of water, and not too great an increase in the speed of the current.

It was also obvious that either there was an obstruction on the bed of the river just upstream of the bridge, or a part of the bridge was projecting from the underside of the structure lower than we thought. The *Wasserstrasse* favoured the latter, and we the former theory. The water level was now falling fast, but there was always the possibility that the floods might come again any day, and we could not afford a similar failure again if we were to clear the river before the ice-floes came. The divers were rushed down from Hutbergen, only to find they had exhausted their stocks of nitrogen required for under-water cutting. This necessitated a journey to Lubeck, now forbidden without a Corps permit. Two days passed without the permit being granted, so in desperation a truck was despatched to take its chance. Needless to say, it got through unquestioned, and the permit arrived a day later. At the same time I asked for a dredger to be put to work to deepen the channel in the vicinity of the obstruction. It turned out that the dredger was sufficient.

A dry spell kept us waiting until 15th December, 1945, when forecasts of rising floods began to come in from Hameln. This gave us a couple of days to prepare. During the night 18/19th December our crucial water-mark was passed and the river was still rising. *Oker* and *Reinhardt* were already standing by at Hutbergen and the remainder at Baden—ready for the critical part of the operation. At 08.00 hrs., on the 19th, *Reinhardt* took the strain off the anchorages of the Hutbergen structure. *Oker* took the lead downstream to guide the structure and *Reinhardt* thereafter retained a roving commission, ready to nip in where required. The proposed journey was about 10 miles downstream, and past the confluence of the River Aller with the Weser. It was intended originally to allow the stream to do the work with the tug merely controlling the nose, but it was soon found that better speed and control were obtained by taking it down under power. When we reached the half-way mark, the bridge ran aground on a submerged sand-bank—an altogether unexpected incident at this stage. The momentum, however, was now considerable and sufficient for the bridge to plough its way through. The trusses were forced backwards, about 3–4 in. on the gunwales of the barges, but fortunately, the packing remained in position and the equilibrium was not noticeably affected.

By 11.00 hrs. the structure was within sight of Baden, where some half-dozen tugs and barges were waiting to assist. As a result of coming down-stream under power (see Stage 1 on Fig. 1) the structure was travelling much faster than was originally intended—probably about 6 m.p.h. The problem can now only be illustrated by drawing, as the current pulls round the northern bend close in under the bank. It crosses the mouth of the canal, which faces downstream. It was quite impossible to keep to the south bank and turn in, as one would do in a car, the current being much too strong. The structure, therefore, passed the canal mouth fully in the current and was swung round in a complete loop into the slack water under the south bank. To assist the turn *Reinhardt* took a line from the bows of *Oker* and pulled across the stream (see Stage 2 on Fig. 1). *Oker* then came hard down to port and *Reinhardt* should have turned upstream, but instead, its bows struck a sandbank and it stopped. After frantic sound signals, it cast off and *Oker* turned upstream on its own, making no headway at all. By this time the bridge was broadside to the current and about central in the stream, travelling fast in a wide circle until it hit the south bank fair and square. This was a nasty moment, as the packing had already had a bad shaking, and we feared that the packing might dislodge completely under the peculiar stresses caused by such an impact. Only one lot of packing shifted, however, and even

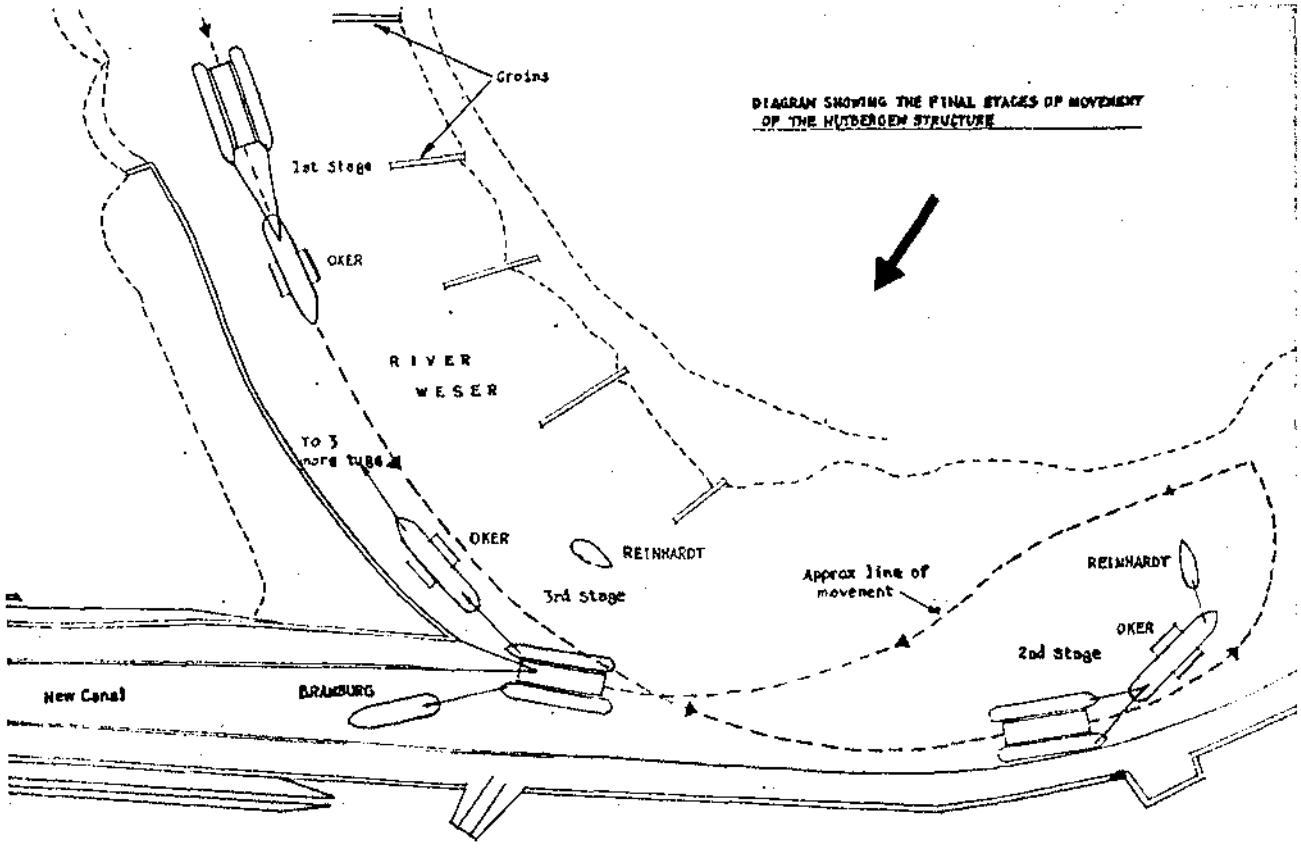

Fig. 1.—Showing 3 stages of the movement of the Hutbergen Bridge down the river Weser.

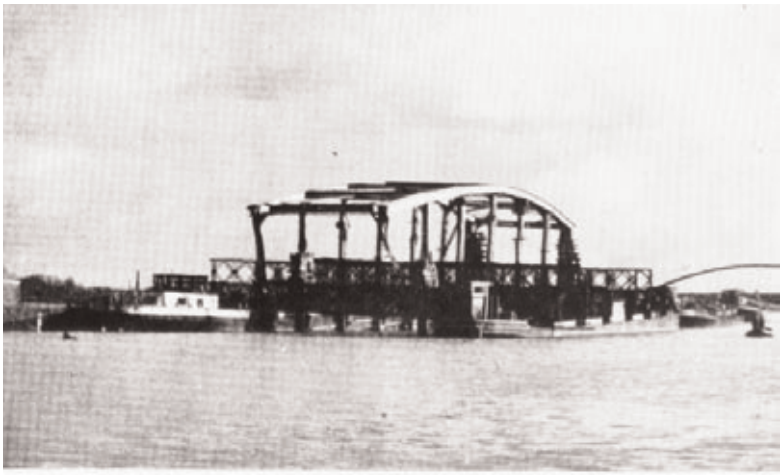

Fig. 2.—Hutbergen Bridge raised on to barges ready for towing away.

Fig. 3.—Usen Bridge raised on barges with tugs Oker and Widder.

Report of clearance of River Weser

that was not serious as it still continued to take its share of the weight. The tugs, which were standing by, now coupled up in line ahead, with the exception of *Bramburg* which kept a loose line from the port bows of the structure. The whole then moved slowly upstream and across until eventually *Oker*, *Reinhardt* and three more tugs were heading upstream beyond the canal, while *Bramburg* pulled into the canal itself (see Stage 3 on Fig. 1). As soon as the structure was in slack water, *Bramburg* was to give the "cast off" signal on its siren and all except the *Bramburg* were then to cast off. By this means, it was calculated that the backwash of the river plus the power of *Bramburg* would take the structure up the canal into position. Unfortunately, the skipper of *Bramburg* was a little slow in giving the signal and just as they cast off, the structure went aground on the spit of land between the river and the canal. Strangely enough, this proved more of a help in the long run, because it enabled *Reinhardt* to go round and take charge of the tail of structure. *Reinhardt* now gently eased the structure off the spit and then turned inwards, while *Bramburg* easily took the lead into the mooring. It was now 12.30 hrs. and we reckoned that the worst of our work was over.

Having had a fairly successful morning, we went straight down to the second bridge at Usen and made ready to cast off there. We had no fears this time about the depth of water, as it was still rising. At 13.30 hrs. *Oker*, *Bramburg*, *Reinhardt* and four powered barges were coupled in line ahead, took the strain and the anchorages were cast off. The whole train moved up at about ½ m.p.h. and this was with every tug working at full power on a straight stretch of river. We had hoped for better speed. The main trouble was the unwieldiness of the train. At the best of times, the barges are sluggish and slow at the helm, therefore, *Reinhardt* was expending most of its power in keeping the head of the column steady. Even then, the train kept swinging clumsily from side to side, quite unable to keep a steady course in mid-stream. *Oker* was skippering this part of the operation, from next in line to the structure, and all orders were transmitted by siren. In spite of all the swinging, however, steady progress upstream was maintained until about 15.30 hrs., when the tugs began to get into the current just downstream of the now familiar Baden bend. It was impossible to use the slack water under the south bank in this case, as the Usen structure was drawing far more water than the Hutbergen one, and we were keeping in mind what had happened to the *Reinhardt* such a short time before. Probably the skipper was over-cautious, and the whole column was very soon hard under the north bank and for over an hour we just held our own, and everyone developed a sense of frustration. The *Wasserstrasse* authorities now recommended abandoning the attempt and returning to the original anchorage a mile downstream. They knew more about navigation than I did, but as the job was within a stone's throw of completion, I overruled their recommendation and told them to continue.

It was quite obvious that we had to take a risk with the shallow water, and pull to starboard. Unfortunately, *Bramburg* was still in the train, and still definitely required there and so was not yet available to take over the task of holding the structure into the mouth of the canal. *Reinhardt*, however, could be spared and once again took its roving commission—a task for which it was particularly suited, as it was well-handled and like a jeep in the water. The minute we pulled to starboard we made progress again, but still very slowly, and we were astride the canal entrance as it became dark. *Bramburg* cast off and took up its position in the canal with a line from the port bows. Needless to say, with the darkness, the same trouble

arose and the structure went aground on the spit. The problem was solved as before, but owing to the darkness, it was 19.30 hrs., before the Usen bridge had joined its sister from Hutbergen in the canal.

And so one more stage in the task was completed, and there was no more to do except prepare and wait for suitable weather conditions for the last stage. Operations had been successful so far, and we had every hope for the last stage causing little trouble. Daily forecasts of rise and fall of river levels were forwarded from Hameln so that adequate warning was available. On 29th January, 1946, we had a visit at Baden from Sir Donald Bailey, who expressed his interest in the unorthodox use of the equipment.

Meanwhile, snow had been falling fairly heavily in this area and even more so in the mountains in the south, and the *Wasserstrasse* began to show signs of excitement again. The next stage of the operation was being carefully laid out on paper, but the old doubt arose once again as to whether the structures were to be disposed of as we intended, i.e. by grounding on the hard on the south bank of the River Weser, or to be left floating, with a view to their reinstatement. The I.W.T. in Hanover apparently originated this doubt, but they did so direct with the *Wasserstrasse*. Confirmation was requested, but was not immediately forthcoming so, as time was short, we continued with our preparations to proceed as if the orgiinal plan were unchanged. On the 8th February, conditions were ideal as the river was just below peak flood and was still rising. The forecast led us to believe that by noon on the 9th the turn of the flood would have passed and probably the last chance of this season gone. But there was still no word of a decision to continue. I did not tell the *Wasserstrasse* but warned them to be ready to start at 07.00 hrs. on the 9th. The C.R.E. received confirmation, and passed it on to us on the evening of the 8th.

The Usen structure had to be dealt with first, and a double anchor was dropped on the spit of land which was now completely submerged, the river being almost six metres above the normal summer level. A further two anchors were dropped out in the river upstream of the canal mouth and approximately on the edge of the stream where the current began to slacken. *Reinhardt* then pulled the structure down the canal and a cable was taken from the port bow to the first anchorage. The tugs *Oker*, *Widder* and *Moeve* made fast in line ahead to the river anchorage and pulled slowly upstream so that there was a minimum strain on the anchor cable. *Reinhardt* continued to pull downstream until the structure was in the river, held by the first anchorage, and then turned outwards and pulled across the stream. Meanwhile, a cable had been run from the stern of *Oker* to the two bows of the structure. All tugs then pulled full speed ahead, and the first anchorage was cast off. As the stream caught the bows, the structure moved across with the action of a flying ferry, and the pull of the structure began to fetch the tugs downstream slowly, thus letting the full strain very gradually on to the river anchorage. In matter of 30 seconds, the structure had passed through the stream and was more or less safe under the south bank in the slack water (hypothetical, because the river had overflowed on this side). The final position, fixed by three ranging rods on the north bank, was some 150 yds. downstream, and the structure was warped down to the position, the barges supporting the bridge dropping their anchors on the way. At 12.30 hrs., the structure was very nearly in its final position, but not quite. We judged it more important to leave it as it was, fixing the two short anchorages, so that we could go ahead with the second job. Up to this time, the wind had been light and blowing from the north, helping the operation, but it now veered round to an almost opposite direction. In spite

of official forecasts, the river continued to rise rapidly and was now only about 15 cm. below the highest flood level on record (65 years previously), and well above the anchorage level.

The Hutbergen job was exactly similar and went just as well, the fresher wind being offset by the more open structure. Also, it swung across the river almost into its final position—it had only to be moved a few yards upstream. Four anchors, two river and two shore, were again cast by 17.00 hrs. We felt justified in leaving the site in charge of the skipper of *Oker*. He retained his crew of civilians in case of emergencies, as the river was still showing no signs of abating. This was rather worrying because it was obvious that the long shore anchorages would shortly be submerged. However, we considered that the forecast could not be more than six or seven hours out, and as long as this was the case, the shore anchorages were good enough to hold out.

The wind was fairly fresh now, but this did not strike us as dangerous, as it had made only a slight difference to the manœuvrability during the operation. On the whole, it had been a good day's work, and we were well satisfied in the way that the *Wasserstrasse's* tugs had executed their task. We had hoped to wait for the flood waters to recede, leaving the two bridges high and dry on the shingle hard, so that during the summer the steelwork could be dismantled and removed.

The S.O.S. on Sunday morning was a bad shock. At about 03.00 hrs. the Usen structure had slipped its anchorages and set off unattended downstream. It was fortunate indeed that *Reinhardt*, *Oker*, *Widder* and *Moeve* were still standing by, but by now they were all getting short of fuel. The immediate dangers were now three-fold. Firstly, there was the railway bridge. We were by no means sure that the bridge had sufficient head room to get through. Secondly, assuming that the structure could pass this bridge, there was one timber pile bridge and one pontoon bridge at Bremen, and thirdly, there was the danger of the structure striking the bank (or even its old piers), loosening the packing and settling down once again on the bottom and blocking the navigable channel.

By the time *Oker* and *Moeve* had got up steam, the *Reinhardt* and *Widder* were on the way. Before any semblance of control was gained, the structure was getting dangerously near the railway bridge. However, at a point roughly 7 miles downstream, the tugs managed to nose the structure broadside to the stream into the south bank, where it caught itself against a groyne. *Reinhardt* then dashed back upstream to keep watch on the Hutbergen structure. Apparently, the other structure had had its shore anchor cables broken by the strain put on them by the high wind. The wind had then taken the bridge into mid-stream—too much for the two remaining river anchorages. As a matter of interest, the river was still rising 24 hours after the forecast, and eventually broke its own record by about 10 cm. The final level was 6 m. 68 cm. above normal summer level. For two days, hard work went on to sort out the muddle, and a suitable parking place was found just a little way downstream. We soon had the structure lying stern upstream, well inside the shelter of the groynes and clear of the normal summer level. It was safely anchored there—and proved the last of our worries.

The last stage of the operation was left entirely in the hands of the *Wasserstrasse*, because by now the Company had disbanded. They allowed the water to fall back until the structures touched down, flooded the barges, removed the packing and dismantled the Bailey trusses. Next summer, when the bridges will be high and dry, the German Highway and Bridges Authorities intend to salvage what they can of the material.

YACHTING ON THE CHINDWIN

By a Bengal Sapper and Miner.

"AND then "X" Fd. Coy. I.E. will set sail. Good Luck." This was the completion of the order which was to start us out on a ten day journey down the Chindwin River from Manthanyit, on the upper Chindwin, to Kalewa, approximately 130 miles further south.

The company had been running the ferries over the Chindwin at Manthanyit, crossing over "X" Division's stores and transport, and on the completion of the operation we received orders to deliver the equipment to the Bridging Company on whose charge it was, at Kalewa. The orders were greeted with great glee. Ten days on the river, taking things easy and watching the countryside slip by, appealed to us all, but little did we know the job which was in store for us.

The plan provided for one platoon to go by road to Kalewa, taking with it the company transport and part of the stores. The remaining stores and other two platoons were to go by river. The two parties to meet at Kalewa. The river convoy was to consist of five Folding Boat Equipment rafts and one Jap raft with each raft towing behind it 60 ft. of country made bamboo raft on which additional bridging stores, petrol, Army track, etc. were loaded. The equipment rafts were to be propelled with 22 h.p. outboard motors, one on each raft. A motor boat accompanied the convoy and this was to be used as an O.R. boat to control the convoy and give assistance. One Jeep came with the river party and it was loaded on a raft.

By 12.00 hrs., a couple of days after Christmas, the rafts were all loaded up and ready to start on their journey down river. By the time all the stores had been loaded, the equipment rafts were sitting in the water with about a foot freeboard, but the bamboo boats which were only a foot in depth had the water almost lapping over their decks. These rafts were attached with a couple of hefty cables to the F.B.E's.

The whistle went and slowly, very slowly, the first raft pulled away from the beach, hauling behind it its load. The raft had not pulled more than a few hundred yards from the beach when it became obvious that our task was not going to be so easy as we had first supposed. With the drag of the bamboo rafts behind, the outboard motors were not sufficiently strong to be able to keep the two on a straight course. The current was running at about two knots and with the engine going full out we were not making more than an extra half knot. The result of all this was that if the raft behind got slightly out of the line of the current it would be whipped out of its course and turned round in circles. To straighten up again with the engine was practically an impossibility. A complete fiasco resulted with the five sets of rafts whirling round in circles being swept down river completely out of control, with blaspheming raft commanders frantically trying to straighten up their charges. Their efforts were of little avail.

We found ultimately that a certain amount of control could be obtained by slackening and tightening up on the towing cables but even with this, the rafts were still unable to keep a straight course down the centre of the river but would wind their way from one side to the other, occasionally being grounded on shallow spots.

By 17.00 hrs. it was decided it was about time we halted and made camp for the night. The first raft picked a likely spot on the side of the river he happened to be at, at that particular moment and steered the best way he could for the shore. Although everyone knew that we intended stopping at that particular spot the job was to get there, and what a job it was. With the help of the motor boat, in about two hours, all the rafts were got to one side of the river and from there were towed down the bank to what was to be our company camp for the night.

We had made, in a total of five hours running, just over six miles, which was not too bad considering that the current was running at two knots!! Something had to be done, if we were ever going to get to Kalewa at all.

The next morning we transferred the loads, and cut down the bamboo rafts to half their length, and hoped that steering would be a bit more simple. The river mist lifted by about 09.00 hrs. and we cast off. Steering was a little bit easier with the reduced drag, but our speed still left a lot to be desired as we were still only making an extra knot above the speed of the current. We chugged along slowly, keeping to the centre of the river as far as possible, and well clear of any dark bits of water, which might possibly indicate a sandbank. We did not manage to keep out of trouble for long however. At about 13.00 hrs. the front raft hit a sand bank. The one coming behind, trying to avoid the snag, knowingly went to the left, near the bank, but it got into too shallow water and managed to bed itself very nicely. The third raft, seeing the fate of the other two cast its bamboo raft adrift, and it, with its shallow draft, drifted over the sandbank while the main raft, freed of its encumberances was able to steer itself clear quickly and avoid the sand. Sounding as he went along, this raft commander was able to pick up the channel and guide the other rafts through, before going on and picking up his bamboo raft, which had by this time gone about half a mile downstream. After an hour of sweating, pushing and blinding the two rafts were got free, and the convoy proceeded blithely on its way. When it came to stopping to pitch camp that night, the motor boat stood by, and as each raft approached the harbour, pushed it well in towards the shore, and they were able to get in and be tied up without too much trouble. Eighteen miles was the score for that day, which although better than the previous day's effort, was still far below what we were expecting to be able to do in mileage each day.

The next day we were due to reach Sittaung, where there was a road down to the river. We decided to dump there all the army track that we were carrying, and lighten ourselves even more, and try and do away completely with the bamboo rafts, which were slowing down our speed still to a great extent. The next day it was about a three hour run, from our camp site for that night, to Sittaung. Five miles from Sittaung the river suddenly narrowed and swept down a channel of about twenty yards navigable width, for a distance of three hundred yards. At the entrance to this channel there was a half submerged tree, which had been probably carried down in the previous monsoon. The rafts had to be navigated around this tree, and then back into the middle of the channel again. The first three managed it all right, but the fourth one, after coming round the tree, could not get quite back into the middle of the channel again, and it went sweeping through at about eight knots. Half way through the channel, disaster struck.

Submerged, with nothing visible above the surface, was another tree trunk and the raft, speeding along, hit this full fair and square, and holed one of the centre boats so completely that it filled up with water in about twenty seconds. Frantic efforts were made to transfer the load off the damaged part

of the raft to try to balance it, and at the same time to steer for the shore and try to ground the raft before it completely sank. Within forty-five seconds of striking the log, however, the raft was sitting on the bottom of the river. Those who were not very proficient swimmers, cast off on a " Ranger Boat " (a rubber assault boat), which had been kept inflated, resting on the deck for an emergency such as this, while the swimmers struck out for the shore. Every one managed to reach the shore safely, but the raft had completely disappeared from sight, and all that was left to mark the spot was the Jeep, which, unfortunately, had to be on this particular raft, and even it was half submerged. The raft coming along behind was, with difficulty, brought into the bank before it reached the channel, and then warped down with ropes from the bank, past the dangerous part, and anchored in a small creek at the end of the channel.

The thought of all now was how to get out the Jeep and the stores with which the raft had been loaded. These consisted mostly of the Sappers' kits, but there was also a fair amount of engineer stores, which had been loaded on the raft.

To get the Jeep out was going to be a problem, as the water was already half way up the engine and the raft was seating itself more deeply in the sand every minute. The first scheme that we tried was to attempt to pull the raft along the bed of the river until it reached shallower water, in which we could work and be able to transfer the stores on to the bank. We attached cables to the submerged raft, and with about fifty men on the ropes, pulled. In the few minutes that had elapsed, however, in joining up the ropes, sand being carried down with the heavy current was settling over the boats, and very effectively anchoring the raft to the bottom of the river, and making any movement impossible. After two of the cables snapped and deposited the pullers on their backs all in a heap, we gave up attempting to haul it in. It became obvious that if the Jeep was not got out very soon we were going to have to say goodbye to it. The fifth raft, which was anchored nearby, was quickly unloaded and brought along to the downstream side of the submerged raft. Cables were attached from this raft to the submerged one and made fast. A ramp was made, with one end of it in the water resting on the sunken raft and the other resting on the floating one. Timber was put down over the bearers we were using for the ramp to make a roadway for the Jeep wheels. The exhaust of the Jeep was by this time well under water, but by some miracle the starter still worked and the engine started up without any trouble, and with a little help pushing the vehicle, its wheels got a grip on the ramp and it drove itself out and on to the other raft. By diving down to the raft a certain amount of the stores resting in it were recovered. Salvaging of stores went on all the rest of the day, and the majority of the men's kit was recovered. By nightfall, all that had been recoverable had been got out with the exception of the outboard motor, which was still attached to its frame, and this was well under the water. The main part of the convoy had been halted at Sittaung, and the men from the sunken raft, together with the one that had been giving assistance in salvaging, made up camp for the night beside the sunken raft. At dawn the next morning, a very cold and misty dawn, efforts to get at the outboard were again started. After about three hours of work, most of it under water, the engine was freed and taken out.

A hollow bamboo was used to enable the men working under water to work without having to come up every half minute to take fresh air. It was quite successful until it started to leak slightly. It was found a bit difficult then to swallow sufficient water to keep the air passage clear.

By eleven o'clock the remaining raft, with all the salvaged stores and now the

spare men in addition, set out to rejoin the rest of the convoy at Sittaung. This raft was now loaded right down to within an inch or so of the gunwales. If any wave was set up by any other craft passing by, it was all hands to the pumps. At Sittaung, loads were re-distributed and the bamboo rafts discarded.

The company monkey, which had come down with the river convoy and happened to be on the raft which struck the tree, had not had his spirits damped in any way by having to swim for his life, but continued in his usual way hampering the war effort by destroying everything that came within hand's reach. One of the company roosters had also had to swim for it, but he showed his displeasure by taking to the jungle and did not come back again. " A bird in the hand " and he knew it.

The remaining part of the day went smoothly.

The river mist lifted early the next morning and we started off by 08.00 hrs. We chugged along at a good four knots the whole of the day. The usual trouble with sandbanks cropped up, but none caused any serious stoppage and a good distance was covered in that day.

We cruised on past Yanan and Obo, down to Mawlew with very easy navigation and did not strike trouble again until we were almost in sight of our goal. 20 miles from Kalewa the river wound its way past a very steep cliff face, with whirlpools at the bottom of the cliffs. Coming past this, the tendency was for the rafts to be sucked towards this cliff face. Disaster very nearly befell the first raft, which, when seeing the speed of the water sweeping through this gorge, cut its engine out and allowed itself to drift through. The raft was sucked in towards the cliff, and only by a miracle managed to escape destruction by being battered against the cliff face. The form for the other rafts, which got them all through safely, was, as they came into the gorge, to point their rafts away from the cliff at right angles to the direction of the stream, with the engine full out and the crew manning the oars to pull towards the other bank. The rafts were then swept through safely.

Eight days after we started out, at about 12.00 hrs, we could see in the distance the Floating Bailey Bridge which spanned the Chindwin at Kalewa. Our journey was nearly completed. We had managed to complete it in two days less than we had expected.

We reached our final destination by 16.00 hrs and tied up for the last time. The next day the rafts were dismantled and handed over. The task was completed. Then we started out by road to join our company. The Chindwin was left behind us. There were new rivers ahead. Ferries would be required but not, we hoped, a company to take them down to Rangoon. A First Class Mate's ticket is necessary for a job like that.

MEMOIRS

BRIGADIER H. ST. J. L. WINTERBOTHAM, C.B., C.M.G., D.S.O.

HAROLD WINTERBOTHAM was the second son of Canon R. Winterbotham, who had had cures at Brattleby in Lincolnshire, in the Scottish Episcopal Church at Fraserburgh, and at Edinburgh. Harold was born in 1878 and his earliest recollections were of Fraserburgh, amongst the people of " that quiet, purposeful, self-reliant breed," one of whose most striking qualities was their belief in education. The family went to Edinburgh when he was seven, and later on he obtained a scholarship at Fettes. Summer holidays were spent in Fifeshire with visits at intervals to France and Germany. Then to the R.M.A., Woolwich. His chief difficulty in passing in was connected with his colour blindness ; he managed somehow, to get through the tests, but there is no doubt that he was genuinely colour-blind, and on one occasion, at Woolwich, he had some trouble in explaining why, on a military sketch, he had coloured the contours green.

He was commissioned in December, 1897, and, after the usual course at Chatham, was posted to the 38 Fd. Coy., R.E. and embarked for the South African War. He saw something of the operations leading up to Paardeberg and the action at Driefontein, but shortly after this he went down with enteric, as did so many about that time. After a spell in a Fortress Company at home he was ordered to St. Helena where he spent three years.

In 1908 he was put in charge of the topographical survey of the Orange Free State, and took over the Colonial Survey Section, which was a small body, consisting of two officers and four N.C.O.s, formed in 1902. Three years later it was sent to survey the Orange River Colony (now the Orange Free State), under the command of Captain L. C. Jackson, with Lieut. A. S. Redman as his assistant. They did admirable work. In 1908 the time had come to relieve the original party and in August of that year Winterbotham succeeded Jackson, and soon after, Lieut. McNeill succeeded Redman.

The survey was based upon the geodetic triangulation which had been executed by Colonel W. G. Morris, and the officers broke up this work into smaller triangles with sides about 10 miles long. The N.C.O.s carried out the detail survey on the scale of 1/125,000. It was realized that the speed of the survey would largely depend upon adequate transport arrangements, and what with riding horses, draught horses, mules, Scotch carts, Cape carts, a spring wagon and two " spiders " the section had all the transport that it required. The area of the Free State is just over 50,000 square miles and the total cost of the work came to less than £20,000. The official report remarks that, " The greatest credit is due to the officers and non-commissioned officers of the Section who carried this survey to a successful conclusion. Throughout the whole of the period, extending over nearly six years, they never spared themselves nor grudged the hardships incidental to such work. During the whole course of the survey no public holidays were observed. . . . Such prolonged and continuous exertions are quite exceptional."

Winterbotham himself wrote, " The whole section met, say, once a month or less. Officer or N.C.O. we each had our tent and our transport and moved from camp to camp as the work demanded. Every now and again the two officers would meet for a day or two, exchange observations, and then sit down to an intensive wrestle with logarithms, ending up with the dispatch to London of precious field sheets and records of triangulation."

And again, " Camp, of course, meant water, and water, in turn meant a farm dam. Even on the rare occasions when we were near a village we never camped there, but always at some nearby farm, at which there always seemed to be room for the travelling stranger. It was at these farms that we bought our food and the forage for the beasts. Naturally the occasional partridge or korhaan did not come amiss, but our rations were mostly the almost black bread and the nondescript lumps of meat that we got from the farms. . . . The farmers were Dutch to a man, and the war was still fresh in everyone's mind, but we were greeted with invariable courtesy . . . ." " That last year meant harder work than ever, for money was running out. We just scraped home, however, and our final figures, for a real good half-inch map, showed that we had done over 50,000 square miles at rather less than eight shillings a square mile."

On his return from the Orange Free State in 1911 he was posted to the Ordnance Survey and was put in charge of the Trigonometrical Division. Whilst at Southampton he wrote a valuable paper entitled, *An Investigation into the Accuracy of the Principal Triangulation of the United Kingdom*, 1913, which describes the test triangulation at Lossiemouth, carried out for the most part before his time, but completed by him. He deals with the values of the standard bars involved in the various base measurements and with the agreement of the bases.

Winterbotham's most important services to the Army were rendered during the first World War, on the Western Front. He was sent out to France at the end of 1914 in charge of a " Ranging Section " which was formed with the object of fixing, with the aid of an aeroplane observer, positions of enemy guns. This was soon superseded by better methods. About this time the first 15 in. howitzer arrived from England and Winterbotham suggested that he should fix its position trigonometrically with reference particularly to points in the enemy area. His intention was to enable the gunners to find their targets accurately and quickly and to save the ammunition which was necessarily expended in any system of trial and error. The event more than proved that his idea was sound and the R.A. were delighted with the results. This experiment is important as marking the beginning of the system of the accurate fixing of all gun positions and of " Artillery Survey." The importance of this may be shown by a quotation from the *Report on Survey on the Western Front*, 1914–18 :

" The battle of Cambrai began a new era. The tendency to rely for success on a complete artillery surprise was, of course, natural and inevitable. A complete surprise means, however, map shooting and no previous registration. . . . The survey preparations for this battle were therefore most thorough . . . every battery was visited by an officer of the Field Survey Battalions. . . . From this time onwards bearing pickets became a recognized feature of the preparation for attacks." All this artillery survey was under the general control and direction of Colonel E. M. Jack, at G.H.Q.

The fixing of detail for guns and batteries led naturally to the mapping of the whole battle area. In the early days the only map available was the French 1/80,000, which had been enlarged, but was of little value for accurate artillery use. So Jack and Winterbotham decided that the attempt should be

made to re-survey our fighting area. Skilled surveyors from the Ordnance Survey were removed from other army employment and put under Winterbotham, and in due course an excellent map of our own area was produced, with extensions into the enemy area which were based, partly on air photographs, and partly on the old French cadastral and other maps. The value of this new map to the army was incalculable. The survey organization grew from a few small survey sections to Survey Battalions with each Army. Winterbotham was in charge of this work in the Third Army.

Side by side with the growth of surveys there was the development of Sound Ranging and Flash Spotting, in both of which he played a considerable part. On the recommendation of Hedley, then head of the Geographical Section of the General Staff, a committee of three, consisting of an R.A. officer and Winterbotham and Lefroy, R.E., was sent to investigate and report upon the system of Sound Ranging. The R.A. officer had no belief in the method and returned early ; but the two Sappers studied the matter carefully and submitted a report which was a great testimony to their ability and foresight. Their recommendations were adopted. The mechanical perfection of our Sound Ranging apparatus was due to Bull's recording instrument and to Tucker's microphone. To Mr. (now Sir Lawrence) Bragg was due the organization and supervision of the whole admirable scheme.

Winterbotham was also largly responsible for the development of Flash Spotting, that is, the fixing of enemy gun positions by cross observation of the flash of discharge. Though not a pioneer of this method, which had been tried in various forms along the front, he had a large share in organizing it on sound lines, and he was instrumental in getting Hemming, a young Canadian Artillery officer, to deal specially with the method and to Hemming more than to anyone else the success of Flash Spotting was due.

In 1922 he was appointed to take charge of the Geographical Section of the General Staff and whilst there he had a principal share in the founding of that admirable journal *The Empire Survey Review*. In 1929 he was attached to the Colonial Office to inspect various Colonial Survey Departments. In 1930 he became Director-General of the Ordnance Survey, with the heart-breaking task of conducting the survey of Great Britain with a department which had been ruthlessly cut down by the Geddes Committee some years before. He ceaselessly, but without great success, appealed to the authorities for more money, but was obliged to see the national maps getting more and more out of date. He was largely responsible for the adoption of a single projection for all the Ordnance maps on all scales, a really excellent simplification. He wrote a useful chronological account of the O.S. since its foundation in 1791 to the time of his directorship. He retired on reaching the age limit in 1935, but was soon actively engaged upon other work. Notably he became the General Secretary of the International Union for Geodesy and Geophysics. In 1936 he wrote *A Key to Maps*, charmingly written and deservedly popular.

Those who knew Winterbotham will remember him as a kindly, clever, hard working man of varied talents, a fair linguist, something of a cricketer in early days, fond of out-door occupations, a good writer and a witty after-dinner speaker. In 1909 he married the daughter of Mr. A. Stocking, of Barnet. He is survived by his widow, one son and two daughters. He died on the 10th December, 1946, aged 68.

C.F.A-C.

Brig Harold St J L Winterbotham CB CMG DSO

Brig Ken N Simner OBE

BRIGADIER K. N. SIMNER, O.B.E.

BY the death of " Ken " Simner on 27th December, 1946, the Corps has suffered the loss of a widely known and much esteemed officer and one of its leading railway experts.

Kenneth Nugent Simner, the son of Nugent Charles Simner, a barrister, was born at New Barnet on 5th September, 1898. He was educated at Leas Court, Folkestone, and Oundle School. In June, 1915, he passed into the R.M.A., Woolwich and was commissioned as 2nd Lieut. in the Royal Engineers on 19th February, 1916. After a War Course at the S.M.E. he was posted to Aldershot being under the age permitted to go overseas.

He embarked for France on 15th September, 1917, to join the 83 Fd. Coy., R.E. and survived about as long as the average Field company subaltern, being severely wounded in the left leg on 24th March, 1918. Even at this early age Simner had definite opinions on most subjects and had no hesitation in expressing his views in any company. He used to recall how one day in the trenches he was visited by an elderly officer, of unknown rank, to whom he gave a lecture on the iniquities of officers who lived in comfort in the rear areas, sent futile orders to the trenches and generally made the life of the R.E. subaltern even more intolerable than it otherwise would have been. It was only on the following day he discovered that he had been lecturing his own divisional C.R.E. But that was typical of Simner ; he always said what he meant, and in no uncertain terms.

On recovering from his wounds in August, 1918, he went to India where he joined the 2nd Q.V.O. Madras Sappers and Miners, and served in Iraq with the 96 and 12 Fd. Coys. of that Corps, till March, 1921, when he was recalled to the U.K. for a Supplementary Course. His services in Iraq were recognized by a Mention in Dispatches.

On completion of his Supplementary Course at Cambridge University and Chatham, he went for a few months to Aldershot and then returned to India in January, 1924, where he joined the North Western Railway as an Assistant Executive Engineer in the Way and Works Department. For the next sixteen years he remained in civil employment with Indian Railways. In 1929 he met with an accident and suffered serious internal injuries when his trolley was derailed. As a result he had to undergo a major operation, after which he was transferred to the Personnel branch. Some years later, having made a remarkable recovery, he was again posted to the Way and Works branch and was serving as Divisional Engineer, Delhi, at the outbreak of war in 1939.

Almost at once he returned to military employment and arrived in the U.K. in January, 1940. He proceeded to France in March, where he commanded No. 2 Railway Construction Group, R.E., and was amongst the last to be evacuated from Calais on 27th May, 1940, his services being again recognized by a Mention in Dispatches.

After a few months in the U.K. he went to the Middle East, in November, 1940, and served there as Director of Railways for nearly a year until the appointment came to an end when Movements and Transportation were amalgamated in that theatre. He continued his work, however, with the Transportation Directorate at G.H.Q., as D.D.Tn. (Construction). On the railway side, he was directly responsible for the heavy programme of work then being undertaken. The rapid development of two of his more important projects—the Western Desert Railway extension and the Haifa-Tripoli Railway—was in no small measure due to his individual enterprise and to the frequent visits which he paid to the work. There are many Australians, New Zealanders

and South Africans who will remember " Ken " and his outstanding contribution to transportation in the Middle East.

In September, 1942, he went to Paiforce as D.D. Transportation and was responsible, at Teheran, for the working of the Persian Railway, carrying stores to Russia. In this post he later became charged with handing over the operation of the railway to the Americans, and continued to supervise the transfer on being appointed Director of Transportation, P.A.I.C., at Baghdad in April, 1943. Both the Russians and Americans had a high regard for his technical knowlege and ability ; and as always, his very human qualities made him most popular with them.

For some months his eyesight had been failing and medical opinion was opposed to his remaining for another hot weather in Iraq. He therefore relinquished his appointment and returned to the U.K. in February, 1944, to take up an appointment as D.D.Tn. (Rlys.), 21 Army Group. In March, 1944, he underwent an operation for cataract and, though the operation was successful, it seemed very doubtful whether he would be able to accompany 21 Army Group to the continent. But he was determined to take part and crossed to Normandy at the beginning of July, 1944. Despite the handicap of poor eyesight he tackled the rehabilitation and reorganization of the liberated railways with his usual energy, and by the end of October had organized a reliable railway service from Normandy to Holland. It was then apparent that the war in Europe could last only a matter of months and Simner was recalled to England to assist in setting up the organization for the control of German Railways. By V.E. Day his task with the Control Commission was finished and he joined the Transportation Directorate at the War Office as Inspector of Transportation, and later as Deputy Director. He was serving in the latter appointment when, in December, 1946, he contracted an infection of the blood ; but the strain of his labours throughout the war had undermined his constitution and he passed away at Millbank Hospital in the early morning of 27th December.

He received substantive promotion to Captain on 13th December, 1925, to Major on 31st December, 1934, to Lieut-Col. on 27th September, 1941, and to Colonel on 16th May, 1944. He was made acting Lieut.-Col. in March, 1940, acting Colonel in November, 1940, and acting Brigadier in April, 1943. His services were recognized by two further Mentions in Dispatches (in 1943 and 1945) and by award of the O.B.E. in 1942.

His friends will remember him best for his honesty of purpose, his technical ability, and his cheerful disposition which acted as a tonic to all in times of stress and anxiety. Though he was outspoken and his colleagues and subordinates were well used to the rough side of his tongue, they knew very well that there was no venom behind it. Simner always knew his own mind and was never a Yes-Man, but when the decision went against him he would accept it and carry out whatever he had undertaken with the utmost loyalty and devotion to duty.

He had to bear many misfortunes—accidents, wounds and latterly the fearful handicap of failing eyesight—but he was always cheerful and optimistic. This was due in no small measure to his very happy family life. On 5th September, 1922, he married Hazel Laura May, daughter of G. E. Lillie, of the Indian P.W.D., who survives him, as do his son and daughter, born in 1924 and 1925. His son held a commission in the Royal Engineers during the war and served on active service in Italy. They have the deep sympathy of his many friends in their great loss.

R.F.O'D.G.

BRIGADIER-GENERAL H. J. M. MARSHALL, C.B., C.M.G.

HUGH JOHN MILES MARSHALL, the son of Maj.-Gen. W. E. Marshall, Indian Staff Corps, was born in India in 1867. He was educated at Wellington and the R.M.A. and was commissioned in the Royal Engineers in 1887. After completing the usual course at the S.M.E. he was posted to the Madras Sappers and Miners at Bangalore in 1889, with whom he served for the next sixteen years including service in Burma and China. He was a subaltern with No. 4 Coy. of Madras Sappers and Miners during the Chin-Lushai expedition and commanded the No. 3 Coy. with the China Exp. Force in 1901. He returned to India later that year with this company and was stationed at Secunderabad. At the end of the year he was granted leave to the U.K. and in 1902 was temporarily posted to the S.M.E. at Chatham.

On returning to India he was posted to command the No. 2 Coy. Madras Sappers at Chakdara and in 1904 was commanding No. 10 Coy. at Bangalore.

After completing sixteen years with the Madras Sappers he was transferred to Works Services and posted as G.E. Meerut in 1905. After holding appointments as A.C.R.E. Jubbulpore and G.E. Nasirabad, he returned again to the Madras Sappers as Superintendent of Park in 1909, which appointment he held till 1912 when he was posted as A.C.R.E. Bannu, and was holding this appointment on the outbreak of the first World War in 1914, when he was a Lieut.-Col., having been promoted Major in 1905 and Lieut.-Col. in March, 1914.

In April, 1915, Marshall was appointed C.R.E. of the 48 Div. in France and served with this division during the battles of the Somme in 1916. In February, 1917, he was appointed C.E. XV Corps in France and was present with this Corps during the German retreat to the Hindenburg Line. In November, 1917, he was appointed C.E. XI Corps, at the time that this Corps was transferred to Italy, and he served with this Corps at the battle of the Piave. In March, 1918, the Corps returned to France and was present at the battles of the Lys in April of that year and later from August onwards, in the final advance to victory through Flanders and in Artois.

For his services during the war he received the C.M.G. in 1916, the C.B. in 1919, and also the French Croix-de-Guerre and the Italian Order of St. Maurice and Lazarus.

He was promoted substantive Colonel on 1st January, 1918.

He returned to India after the war and held appointments as C.R.E., 2 (Rawalpindi) Div. and C.E. Northern Command, India, in 1920, D.D.W., U.P. District, Meerut, and D.D.W. Western Command at Karachi in 1921 and Chief Engineer Western Command in 1922.

He retired on 5th September, 1924, with the Honorary rank of Brig.-Gen. and went to live at Bexhill-on-Sea.

He married Sarah Catherine, the daughter of J. Gillan, Esq., of Penrhyn, Stourbridge, in 1909, and had two sons.

Marshall was one of those quiet, kindly officers, who are always ready to help others, and at the same time was thoroughly proficient in his work, a good friend to all who knew him and a delightful officer to work with.

C.C.P.

LIEUTENANT-COLONEL G. S. KNOX, C.M.G.

GEORGE STUART KNOX was born in September, 1871, and was the son of Major James Knox of the 19th Foot and one time Governor of H.M. Prison at Wandsworth. He was educated at Cheltenham and the R.M.A. and was commissioned in the Corps in 1891.

Practically all his service was spent on survey work in England, Ireland, Jamaica, East Africa and Malaya.

In 1913 he was Asst. Surveyor-General in Malaya but returned to the U.K. on the outbreak of war in 1914.

Those of us who have served with George Knox in war or in peace will not forget that small upright figure and that clear direct manner. He set himself a high standard in all that he undertook and expected the same of others : he had no use for compromises, excuses or slackers. But to those who tried he gave all his help and kindness. Once you gained his confidence you had a true and generous friend in " Knockus."

Before 1914 Knox made a name for himself in Survey ; neat, painstaking and methodical and a good mathematician, he was an outstanding surveyor : and the Colonial Office was fortunate in having his services for many years in East Africa and Malaya, where his trigonometrical work will stand for all time.

He was never robust and he never spared himself ; and the tropical climates in which he worked for so long took their toll.

He never seemed to know or care what he ate or drank ; and we soon learnt that when we met George Knox on Safari, it was kinder to both parties to ask him to dinner before he asked you. Knox's porters returned to him again and again ; they liked his strict impartial discipline, his care of them and his quiet sense of humour : and no one is a better judge of men than the African porter.

In the winter of 1914–15 he raised and trained at Shorncliffe and Aldershot the 69 Fd. Coy., R.E. and one of us was fortunate in being second in Command of that very happy unit. The company formed part of the 12th Division which embarked for France in May, 1915. Knox remained in command of the Coy. till late 1916, when he was appointed a Corps C.R.E. He demanded and maintained a high standard of discipline. No slackness was overlooked and yet every officer and every man was ready to follow their beloved commander wherever he might lead them.

He had a friend in an old pipe which owing to the lack of feathers got less cleaning than it deserved. The result was an odour pungent indeed and especially noticeable in dugouts. The subalterns decided that the best remedy lay in a presentation without explanation, of a new pipe, specially procured from London. How pleased he was and so were his subalterns.

Completely unselfish and thoroughly efficient in all his work he set us all a wonderful example. For his war services he was made a C.M.G.

In 1919 Knox retired : he had given his services and used his strength unstintingly, and his heart began to give him trouble.

In October, 1912 he married Clara, daughter of Finlay Campbell of Brentridge, Sussex and she survives him. In the inter-war years he and his wife lived in Scotland and in Devonshire, where their friends were always welcomed with true old fashioned hospitality.

And so has passed on a great gentleman *sans peur* and *sans reproche*.

G.C.W. and W.G.

BOOK REVIEWS

OPERATION VICTORY

By Maj.-gen. Sir Francis de Guingand K.B.E., C.B., D.S.O.

(Hodder and Stoughton, 25s. 0d.)

This is the personal record of the war service of the officer who was Chief of Staff to Field-Marshal Montgomery from El Alamein to the final surrender in Germany. It is not a complete history, since the standpoint varies with the author's changes of appointment, and he is at pains to confine himself to events of which he has first-hand knowledge. The absence of hearsay evidence and gossip, while depriving the book of some of the spice with which personal records are apt to be liberally sprinkled, makes it all the more valuable and welcome. Whatever else may be written, official or personal, plain or coloured, on the great events of the years of recovery and victory, this book should be widely read and studied.

Field-Marshal Montgomery is notoriously a " picker " of his team, yet he acquired his Chief of Staff by chance. De Guingand had become head of Intelligence in the Middle East and was sent for in July, 1942, by the then Commander-in-Chief to take over the post of B.G.S. of the Eighth Army, which he (General Auchinleck) had gone forward to command in person after the fall of Tobruk. This was de Guingand's first experience of operational work and he felt far from happy about his appointment. But no one could serve in such close touch with " The Auk " without enjoying and profiting by the experience, and the author records the admiration and affection with which he came to regard his Chief. When after the visit of the Prime Minister, the changes in the High Command were made, de Guingand expected to be one of those to be moved. Indeed, Montgomery said to him : " If you happen to be one of them I will see that you get something good." That was the last heard of the matter, and when the Commander of the Eighth Army was later withdrawn to command 21 Army Group his Chief of Staff accompanied him and stayed to the end. Accordingly, in *Operation Victory* we are given the battles from El Alamein to El Hamma (a period during which Eighth Army was very much on its own) in some detail ; then the planning of the Sicily landing and the Italian campaign as far as the Sangro through the eyes of an army which formed part of a larger formation ; and finally the planning and execution of the concluding campaign as seen from H.Q. 21 Army Group.

The story begins with the author's tenure of the post of Military Assistant to Mr. Hore-Belisha, then Secretary of State for War, a post which lapsed with the succession to office of Colonel Oliver Stanley. A vivid chapter on the Greek adventure begins on an evening in January, 1941, when the Joint Planning Staff in Cairo (of which the author was the military member) had just completed a study for the capture of Tripoli, and had decided that it was by no means impossible. At this moment a telegram arrived which was to change the whole framework of British strategy. The North African campaign was to be strictely limited, with Benghazi as its high-water mark, and first priority was to be given to the collection of forces to help Greece. No wonder the planners felt deflated and sad, as their paper (and with it their hopes) went into the waste-paper basket.

Armed with lists of equipment and munitions, de Guingand accompanied Mr. Eden's party to Athens to discuss the offer of assistance to Greece with the King and his advisers. He stayed on in the guise of a war correspondent to take part in a reconnaissance of the Aliakmon position and saw something of Albania and the Greek Army. He gives his reasons why " intervention in Greece never had any chance of success," although on an earlier page he admits that " Yugo-Slavia appeared to be the one bright spot. If they had really fought the Germans, then the whole thing might have been worth while." His view is that failures, even gallant ones, do not in the long run help a nation at war in the eyes of neutrals. Success is what matters. Did we in fact mislead the Greeks into thinking that our help would be effective ? Above all, did the politicians force the soldiers' hand ? The last word on this question has undoubtedly not been written, nor upon the cognate question of Crete. Could more have been done beforehand to prepare the island for an effective defence? Perhaps ; though the fact remained that the German Airborne Army received a severe shock, and never again did the Germans attempt an airborne operation on such a scale.

The greater part of the book is, in effect, a study of the exercise of command. The author is not alone in his view that insufficient attention had been paid to the training of our potential higher commanders. This is, of course, a thorny question, for if we have only a small army in peace-time—and that scattered all over the globe—how can any of its officers gain practical experience in commanding large forces ? It is doubtful whether we made the best use of such opportunities as there were, since the tendency to direct an exercise rather than command one of the sides was very noticeable. Nevertheless, it is essential to analyse thoroughly—and not merely take note of—the methods of those leaders who have commanded successfully in war. In so far as there is a craft of command their methods will show much in common ; in so far as successful command is an art there will be displays of individuality in abundance. Both these aspects of the practice of command by Field-Marshal Montgomery are fully treated in *Operation Victory*.

The character-study of this Commander by one who knew him so well and saw him not only on the stage but in the dressing-room and wings is, therefore, to a great extent the *bonne bouche* of the book. It contains no startling disclosures, and, for many people, no surprises. It confirms many of the prevalent or popular impressions. It emphasizes the Commander's insistence on being known to his troops and securing their confidence ; his personal example of vigour and assurance ; his care to make his views and orders crystal-clear ; his habit of choosing and nursing his subordinate commanders, treating them not all alike, but so as to get the best out of each ; his ability to sit back and rest, while leaving the staff to get on with their work. Above all, never failing to give a decision or to " take hold " when required, as at 3 a.m. on the third day of El Alamein, when by his firmness and refusal to fuss (" belly-ache " is the word he would use himself) he restored the impetus which for a moment seemed to be in danger of flagging.

There is never any lack of good stories about a forceful personality ; they are the verbal equivalents of the cartoonist's caricatures. The Field-Marshal earned his full share of them, which makes all the more welcome an authentic anecdote like the following. In mid-February, 1943, the enemy achieved a success against the 2nd U.S. Corps and, on the 20th February, General Alexander, realizing the seriousness of the situation, asked Montgomery if he could attract Rommel's attention and so reduce the pressure on the Americans. His reaction was immediate and generous, although it meant

upsetting the carefully worked-out programme which was to lead to the battle of Mareth and accepting the risk of being caught in an unbalanced state of deployment. By the end of February, the 15th and 21st Panzer Divisions were concentrating against the Eighth Army and the 10th was expected as well. Fortunately Rommel missed his chance and by 5th March, Headquarters Eighth Army breathed freely again. On that day the Chief-of-Staff reported to his Commander and asked him how he had felt during the last few days. "The Army Commander had shown no outward sign of anxiety but had gone everywhere looking the picture of confidence. He admitted to me then that he had sweated a bit at times."

The author himself is able to be generous, too, and never suggests that Eighth Army had a monopoly of successes. Thus, of G.H.Q. Middle East he writes: "I was very impressed with the way he (Alexander) worked with Montgomery . . . He knew the new Army Commander's ability and decided to give him his head . . . I am sure Montgomery will not deny that he received magnificent support from behind." Again, of the First Army, of whom there had been at one time some criticism: "The weather factor we never properly appreciated. We had our smugness removed in Italy when we met for the first time a European-type winter . . . It is, therefore, with no attempt at being patronizing that I now say 'Well done, First Army, who under such difficult circumstances played so noble a part in the destruction of the Axis forces in North Africa.'"

The author does not, of course, suggest that the figures on his screen were invariably seen at their best, and that no discordant sounds were ever heard. Is it not in overcoming the difficulties that arise from the interplay of strong characters that the "big men" have shown where their real strength lies? By mutual trust and a proper spirit of understanding, by tolerance without weakness, the complex machinery of Command and Staff can be made to work, and work well. No two people exerted a greater influence to this end than General Eisenhower and his Chief of Staff, Bedell Smith; of this the author is clearly convinced. One short anecdote will illustrate the former's understanding, at a time when he himself was under heavy fire from the American Press on account of the slowness of the progress in Normandy. "I know Monty's difficulties," he said to de Guingand, "but from the bigger point of view it is important that the attack should go in before then. Do you think it can be speeded up?" . . . Montgomery responded immediately. He telephoned to say that he would do his very best to speed up the attack, and this he subsequently managed to do.

This leads one to the general question of relations with the Press in war, which the author, acutely aware of its importance, does not hesitate to tackle. He draws conclusions from his own considerable experience, but the matter is not disposed of. No one will doubt that the correct British approach to the problem is: "You can help us and we can help you; how can we best work together?" (The presence of allied pressmen is a complication.) Many officers and, no doubt, many pressmen have worked on these lines, and with a very fair measure of success. When operations have been going well their work has been comparatively simple. But if there is a lack of juicy bones to throw to the Press will not some of the hungrier members start rummaging in the dust-bin?

"I agree," writes de Guingand on the subject of press criticism "that a commander in Montgomery's position should be unaffected by such things, but on the other hand there were considerable dangers that these outspoken comments might have had an effect upon the fighting qualities of the troops . . . If they continually read articles criticizing Montgomery or

at any rate suggesting that all was not well, they might lose faith in their Commander-in-Chief. Here, then, was the danger." On this occasion the Field-Marshal held a Press Conference, but even he, with his long series of victories behind him, and with his clarity of exposition and well-known consideration for the Press, did not, in de Guingand's opinion, succeed in "getting across." One wonders whether the whole thing is best left alone, or whether anything could be done in peace-time to help the Press to prepare itself for this vitally important part of its war-time rôle.

I.S.O.P.

STRATEGY AS EXEMPLIFIED IN THE SECOND WORLD WAR: A STRATEGICAL EXAMINATION OF THE LAND OPERATIONS

By Lieut.-Col. Alfred H. Burne, D.S.O.

(Cambridge University Press. 5s. 0d.)

This most interesting booklet contains, in a slightly modified form, the Lees Knowles lectures for 1946.

It consists of four chapters dealing respectively with Strategical Theory ; Poland, Dunkirk and Russia ; North Africa and Italy ; Japan and North West Europe.

The debatable subject of strategical theory is ably and interestingly handled. The author stresses the incalculable factors of time and chance which tend to render warfare anything but an exact science. He finds that the one strategical factor common to all decisive victories is the existence or production of an anvil as well as a hammer. He shows that Von Moltke's preference for the conduct of strategical operations on exterior lines, as opposed to Napoleon's doctrine of interior lines, was mainly due to the development of means of inter-communication and transportation during the intervening period.

The author deplores the lack of English strategical writers of international fame between the little known General Lloyd and Hamley. He has, apparently, no great opinion of Clausewitz.

In the three subsequent chapters, Col. Burne confines himself to the study of the strategy of the various campaigns of the recent war ; and resolutely avoids any discussion of tactical considerations.

In Chapter II his description of the Russian strategy on the East Prussian front in 1944 as compared to that of 1914 is of particular interest.

Chapter III deals with all the campaigns in Africa and those in Sicily and Italy. The author comments on the lost opportunity at Anzio.

Perhaps the most interesting feature of Chapter IV is the recognition of the part played by chance in reducing the prospects of a successful outcome to Von Kluge's bold counter-offensive in the Falaise Gap. The flexibility shown by Field-Marshal Montgomery in altering his plan to meet the new situation is also noted. At the end of the chapter the effect of the cessation of the direct advance on Berlin from the West in April, 1945, is discussed.

The book contains only 86 pages of clear type and is highly condensed. The author wastes no words and is clear and interesting His comments merit serious consideration. This book is recommended to all military students. It will well repay study and reflection.

R.M.S.

ARAB COMMAND

By Major C. S. Jarvis, C.M.G., O.B.E.

(Published by Hutchinson and Co., Ltd. Price 18s. 0d.)

Any book written by Maj. Jarvis about the Arabs in the desert country of the Middle East is always full of interest, interspersed with humour. This book, which is really a biography of Lieut.-Col. Peake, Pasha, has the added interest of giving, what must be to many readers, the first account of an officer who has played a most important part in the affairs of the Middle East.

The name of Lawrence of Arabia is well known in connexion with the Arab rising against the Turks during the 1914–18 War, but little has been written or heard of Peake who carried on Lawrence's valuable work with the Arabs in Trans-Jordan after the war. It is, however, to Peake's influence with the Emir Abdulla, now King of Trans-Jordan, and to the active part he played in command of the Arab Legion that Trans-Jordan and to a certain extent other neighbouring Arab tribes remained peaceful during many years of difficult times in Palestine.

At the beginning of the 1914–18 War, Peake was serving in the Sudan and after various vicissitudes he was ordered, in April, 1918, to take command of a detachment of the Egyptian Camel Corps and to join Lawrence's Arab Force at Akaba. From this time, up till the end of the Palestine Campaign, Peake's Camel Corps, to which a detachment of Gurkhas was added later, carried out a series of most successful raids on the Hedjaz Railway, under Lawrence's directions, all the way from Maan to Syria.

Immediately after the Turkish surrender Lawrence returned to the U.K., as he considered that his task with the Arabs was completed. Peake stayed on, and at the time of the Armistice in 1918 was back again at Akaba in Command of that district.

In October, 1920, Peake was given permission to raise a force of five officers and a hundred men, to be called the Arab Legion, to maintain order in Trans-Jordan. The next year the strength was raised to 1,000 men. From then onwards, till he retired in 1939, the story is one of thrilling adventure—on more than one occasion he was captured by Arabs and was on the point of being killed—of skilful diplomacy and tact and of foresight. By his skilful handling of many difficult situations he not only kept the Arabs peaceful but also promoted their well-being and prosperity, while at the same time preventing trouble in Trans-Jordan during the Arab risings in Palestine.

That he was truly loved and taken to their hearts by the Arabs was amply manifest when he came to leave in 1939 and the country as a whole turned out to bid him farewell.

In 1930, Maj. J. B. Glubb, O.B.E., M.C., who was a Sapper officer till he retired in 1927 when he was employed on political work in Irak, was brought in as Peake's Second-in-Command of the Arab Legion and he was allotted the special task of settling the many disputes and of putting a stop to raids which were being made by the Bedouin tribes on the Trans-Jordan frontiers. In this Glubb was abundantly successful and his knowledge of Arab Law was invaluable. Glubb quickly made a name for himself and his fair dealing made him respected and trusted throughout the Bedouin world. He was thus in an excellent position to carry on the good work started by Peake.

Maj. Jarvis's intimate knowledge of the Arabs and the country and his friendship with Peake have enabled him to produce a most interesting book, full of much little-known history. He also includes one or two brief but interesting sidelights on the French control in Syria as well as on the Jews in Palestine. A book to be recommended to all.

C.C.P.

"CUSTOMS OF THE SERVICES"

By Group-Captain A. H. Stradling, O.B.E.

(Published by Gale and Polden. Price 5s. 0d. 91 pages.)

The title of this small work is somewhat misleading. One expects to be let into the secrets of the behaviour of our friends of the Royal Navy and Royal Air Force: one opens it, therefore, with pleasurable expectations as of a child entering Whipsnade for the first time. But it is in fact, a manual of service etiquette for officers of both the Army and Royal Air Force, although addressed more particularly to the latter.

As such it covers the usual field of such manuals of "What every young officer should know," viz: "The Officers' mess," "Leadership and man management," "Discipline," "Relationship between officers and men," "Social responsibilities" (including the mysteries of "calling"), "Courts and other ceremonies," and it covers them well. Here is no post-war Army and Air Force, but all the rigours of pre-1914 army and social ceremony. It is amusing for a much pre-1914 reader to be reminded of the points which were drilled into him by the Training Battalion Adjutant of those days, and they are all here. But did we need to be reminded not to address our Commanding Officer in the mess as "old boy"? I think not. Nor would the T.B. Adjutant of those days have allowed that the Adjutant's office was "not a quarter-deck" in the matter of saluting. On the other hand we were certainly less formal in some ways in the ante-room than our author would have us to be; but, if he errs, it is on the right side.

The author acknowledges the approval of the Air Council and the assistance of Army officers known to and highly respected by your reviewer, who hesitates therefore to hint at disagreement. But surely the advice on the giving and answering of mess and private invitations on pages 74 and 75 is not too safe a guide. One fears to particularize, but one should certainly insist that the full detail of the invitation should be repeated in the acceptance and especially the date and *time* of the entertainment. Nor would the examples of replies to private invitations make a favourable first impression on a hostess of the old school. It is a pity that that nasty hurdle for the Y.O., the acceptance of an invitation for Honorary Membership, has been omitted.

But these are small blemishes, and the manual will prove useful especially for those who have to instruct the budding officer.

L.V.B.

"BEAGLE AND TERRIER"

By Roger Free

(Published by Chapman and Hall. Price 8s. 6d.)

This little book deals with the training and management of a small pack of beagles used for rabbiting and terriers used mostly for ratting. The author manages his kennel single-handed and as a spare-time hobby. The book contains much useful practical information on the layout of kennels for this purpose, and on the care of dogs in general, including their training, but does not throw much light on the art of hunting the hare.

R.M.W.M.

"WHO DIES FIGHTING"

By Angus Rose

(Published by Jonathan Cape, London. Price 8s. 6d.)

It is common knowledge that during the retreat through the Malay Peninsula in the early days of the Japanese War the 2nd Battalion, The Argyll and Sutherland Highlanders, added a splendid chapter to the proud record of their Regiment. For this reason alone the personal narrative of one of their Officers cannot fail to be of interest.

From 1940 onwards the author witnessed the Malayan scene from several viewpoints. He was successively a Company Commander, a Staff Captain "Q" at Command H.Q., and Brigade-Major at Penang. When war broke out he was G.S.O. 2 Training at Command H.Q. and shortly afterwards became involved in a series of partly advisory, but mainly executive, rôles with various *ad hoc* task-forces, including Royal Marines, Australians, and Local Forces, wherein neither variety nor excitement was lacking. He rejoined his Battalion in time to take part in the withdrawal across the Johore Strait and in the first engagements after the enemy had gained a foothold on Singapore Island. He was spared the horrors of captivity through being one of those who were withdrawn before the fall of Singapore so that their experience might be used for the benefit of others whose task it would be to drive the Japanese from the invaded territories.

All this is vividly and frankly told, with occasional lapses into a facetious style which may have been adopted to illustrate the author's determination not to be "got down" by circumstances, but which is nevertheless irritating to the reader.

The author tackles the delicate question of blame as resolutely as if he were running one of his Commando-type operations. Many of his apportionments of responsibility are reasonable enough in the light of the facts as then known to him, but the full story may show some of his implications to be less than fair. For instance, the decision to call off the projected advance into Thailand did not rest with Malaya Command.

Throughout the book there is a healthy admiration for tradition and discipline, in the best sense of these words. The author expresses his uneasiness of modern trends thus :— "We are a democratic nation, but how many of us realize that we owe our existence to the security afforded by the disciplined units of the fighting services, and in a disciplined unit democracy has no part." This is a typically frank comment, which inevitably leads one to reflect that perhaps it depends upon what you mean by democracy.

I.S.O.P.

MAGAZINE REVIEWS

GEOGRAPHICAL JOURNAL

(Published by The Royal Geographical Society, London)

July–September, 1946.—In " High Latitude Flying by Coastal Command," Air Chief-Marshal Sir Philip Joubert gives an account of the strategical aspects of air operations in high northern latitudes, and emphasizes the vital importance to this country of having suitable bases on convoy routes, and of the study of air navigation and air operations in high latitudes ; while Lieut.-Commander Glen tells the story of the actual fighting that had to be undertaken in support of the convoys to northern Russia.

F. C. Stern deals with " Plant Distribution in the Northern Hemisphere " in an article which is mainly botanical.

E. H. G. Dobby discusses " Some aspects of the Human Ecology of S.E. Asia." (For the benefit of those who wish to look up the meaning of this word in the dictionary, it is there spelt Oecology, and is described as " the science of animal and vegetable economy.") An interesting point that is mentioned, among others, is the failure of clean, well-kept plantations, owing to the neglect of the natural " jungle " conditions, in which the soil is protected from excessive sun by the overhead growth and is nourished by the falling and decaying leaves.

Dr. J. V. Harrison describes journeys in Luristan, a wild mountainous district on the borders of Iraq, with very fine photographic illustrations.

G. R. Crone gives an interesting account of a manuscript atlas by Battista Agnese, which came to the Society from the Yates Thompson collection.

T. H. Bainbridge discusses movements of population in Cumberland and R. Rees Rawson describes two new railways in S.E. Asia, the Burma-Siam Railway and the Kra Isthmus Railway, both constructed by the Japanese for war purposes ; and questions whether they will survive in peace conditions.

E.M.J.

ROYAL INDIAN ENGINEERS SUPPLEMENT

(Published by E.-in-C.'s Branch, G.H.Q., New Delhi)

We extend our best wishes to this new periodical which started life last January and is to be published quarterly.

This issue contains a seniority and location list of regular R.I.E. officers and a series of short articles, and as such is on similar lines to the early issues of the *R.E. Journal.*

The E.-in-C., in his Foreword, says that he hopes from this beginning will develop rapidly a fully-fledged Institution of R.I.E. To this we add our wishes for success and progress in the future.

C.C.P.

JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA

(Published by the Civil and Military Gazette, Ltd., Lahore)

October, 1946.—*India's Post-War Armed Forces.*—The Commander-in-Chief outlines his plan for India's post-war armed forces on the assumption that India will remain within the British Commonwealth of Nations. For the Navy he proposes a small well-balanced fleet with three cruisers as a nucleus, for the Army a corps headquarters with corps troops and an unspecified number of Indian divisions, complete with ancillary services, as a nucleus of a field army, and for the Air Force a balanced force of fighter, bomber and transport squadrons, formed from the existing ten fighter squadrons of the present Indian Air Force. The supply of officers for all three services is to be met by a new Indian " West Point " for 2,500 to 3,000 cadets, to be built probably in the Poona area.

The most interesting change of policy is the proposal to replace regular troops in the tribal areas of the western frontier by civil armed forces, i.e. Scouts and Militia Corps, supported by frontier brigade groups of regular troops. How far the above policy will be followed by an independent India remains to be seen.

Army/Air Organization for India's Defence. The author, Commander 2 Indian Airborne Division, while admitting that to meet India's immediate needs a small army and air force organized and equipped on last war lines is necessary, considers that atomic weapons have made the use of the cumbrous division of the last war and heavy tanks ineffective. In future the predominant arm in the defence of India must be the Air Force, in sufficient strength to maintain air superiority over India's frontiers and to transport and give air cover to airborne battle groups of the army when dealing with enemy airborne landings. Other essentials dealt with are the countering by the civil government of Fifth Column activities, which must always precede an airborne invasion, and preparations to make use of a large number of small sea ports, lacking facilities, and small dispersed bases and storage depots supplied and supplying by air transport.

Military Geology and what it means. An interesting lecture which brings out the necessity for all military engineers to have a basic knowledge of what geologists can and cannot do, and the importance of calling in the geologist at the planning stage of any operation. In South-East Asia Command geologists assisted engineers in finding water and stone metal, the siting of bridges and the detection of land mines, and the staff in the indication of " going " and trafficability and the analysis of coast lines. The importance of photo geology, the construction of geological maps from air photographs, was stressed. Without a small peace-time cadre of military geologists studying future military problems the army will be caught unprepared again. It is interesting to note that that the Germans employed over 200 military geologists in the European theatre, while the Chief Engineer B.E.F. had only one up to 1943, later increased to eleven, the same number as employed in South-East Asia Command.

Indian Engineer's New Honour. A short article on the origin and history of the three Corps of Sappers and Miners up to their incorporation into the Royal Indian Engineers.

Other articles of local interest are *Three Years with the Chin Levies*, *A P.O.W. in Japan*, *Visit of the Indian Contingent to England* and *The Valley of the Gods*, an account of a leave spent in Kulu.

C.G.M.

THE MILITARY ENGINEER

(Published by the Society of American Military Engineers)

November, 1946.—*News Items. Stockpiles of Strategic and Critical Materials.*—The Under-Secretary of War is reported to have stated that the Government is starting immediately to build up a $2,100,000,000 war reserve stockpile. This work will be directed by the Army-Navy Munitions Board. The object is to stockpile during peace, materials vital in war in cases where their source of supply might be cut off by enemy action. Examples given are chromite, graphite, magnesium and nickel oxide. This will eliminate the difficulty experienced in World War II when it was necessary at short notice to improvise substitutes and construct numerous plants to produce substitute material ; frequently by the uneconomical use of resources required for other purposes. This stockpiling scheme is part of the industrial preparedness plan.

War Department Construction Programme for 1947.—In recognition of the pressing need for civilian houses, the War Dept. construction programme for 1947 provides for the postponement of $9,316,000 of Army construction. It also includes plans to proceed with a $44,965,000 schedule of essential construction to provide housing at military stations for military personnel and their families now living in overcrowded conditions in neighbouring towns. Completion of this schedule will release civilian houses for non-military personnel in these localities and thus assist civilian housing. Plans include a considerable amount of conversion of excess barrack accommodation to family quarters. Barrack conversion was decided on because it requires only about 40 per cent of the materials and labour required for new construction.

December, 1946.—*Strategic Thinking.* An interesting editorial on the strategy of World War III, in the light of the increased ranges of air power, and improvements in military equipment. Planning for operations in limited theatres behind short battle fronts is held to be obsolescent. No longer is America at a great distance in time from a possible enemy. No longer are the oceans to east and west Navy patrolled ramparts. To the North is an open door. Routes of attack and lines of communication and supply will be along great circle routes, the shortest lines available, and these great circle routes from American industrial centres to any part of Europe or Asia pass through, or near, the North Frigid Zone. These Arctic waste lands and ice caps are no longer barriers against attack ; aircraft can fly over them and crawler-type tractors can crawl through them. In those uninhabited areas within 1,000 miles of American industrial centres an enemy might establish bases from which to launch guided missiles and aircraft. It is the duty of all to think on correct strategic lines. Our present maps are not helpful. From the habit of looking at Mercator's projection we are accustomed to think of only east and west travel routes between America and Europe or Asia. The Polar Regions are disregarded. Attention is directed to the "Map of the Northern Hemisphere" recently released by the military authorities for distribution to the public. This map was produced by the Coast and Geodetic Survey for the Arctic, Desert and Tropic Branch of the Army Air Force Tactical Centre. More than 2,500 different sources were used in the compilation of the map. Much of the source material used, notably aerial photography, represents the most recent contributions to geographic knowledge. The map is in four sections with an overall measurement of 40 by 66 ins. and is constructed on a polar stereographic projection with a standard parallel at 65 degrees north which passes through the area where a minimum of scale error

is desirable. The scale is 1 in. to 100 miles and covers the area north of 39 degrees 30 minutes.

January, 1947.—*Tests of Engineer Equipment in Operations Crossroads* by Colonel Sherwood B. Smith, Corps of Engineers. An interesting article dealing with the effect of the atom bomb test at Bikini on Engineer equipment placed at various ranges from the explosions. The article covers in some detail the various types of equipment tested and the methods of placing and securing this equipment in ships at approximately ½ mile, 1 mile and 1½ miles from the target centre. Included in the many items of equipment tested were the standard Caterpillar D.7 angledozer, rafts of floating bridge M.4 and M.4 A.2, water equipment, theodolites, mine detectors and a 60 in. searchlight. In the air burst test, the *Gilliam* at ½ mile range sank immediately and the only report on equipment was from a diver who found the D.7 angledozer about 60 ft. from the ship with the entire A-frame, engine housing, radiator and driver's seat blown away.

The equipment in the *Dawson* at 1 mile range was not materially damaged except for the searchlights and more delicate equipment. An interesting point was the value of shielding in reducing blast and radiant heat damage. On the *Butte* at 1½ miles range there was little direct damage except for superficial scorching of the seat covers of the D.7 tractor. The raft of bridge astern the *Arkansas* at a distance of ½ mile was completely destroyed and sunk. A diver found pieces scattered over an area 200 ft. in diameter. At approximataly 1½ miles there was no damage to the other floating bridge. In the underwater explosion test it was decided that the reduced blast did not warrant exposure of equipment on decks of ships. One raft of floating bridge was tied astern of the concrete floating dry dock at a distance of approximately ¾ mile, the other astern an L.S.T. at approximately 1½ miles from the target centre. Neither raft of bridge was physically damaged but both remained highly radio-active. Before either could be decontaminated for detailed inspection they went adrift in a squall on the night of 9th August and had to be sunk by a salvage tug. The author records that the most important lesson learnt from the tests was the general high degree of resistance of Army equipment to the effects of the atomic bomb. Engineer equipment is very rugged and the cost of improving its resistance to blast and radiant heat will not be great and would be justified from the standpoint of resisting damage by ordinary bombs.

February, 1947.—*News Items.*—The Army housing programme in America for 1947 has now been approved for the construction of, 5,580 married quarters by conversion of existing barrack accommodation, and 2,133 married quarters in new construction. These quarters are for both officers and other ranks. The cost of new quarters will not exceed $7,500 each. On completion of this programme the Army will have approximately 15 per cent of its requirements for family housing.

March, 1947.—*News Items.—Flood Control Plans.* Lieut.-Gen. Raymond A. Wheeler, Chief of Army Engineers, recently outlined plans of the Engineers for the continuation of flood control and rivers and harbour work, especially in the Mississippi Valley. Stating that there is " no economy in floods," the General outlined the budget recommendations for the fiscal year of 1948, totalling approximately $163,000,000 on general flood control. The budget programme for improvement and maintenance of rivers and harbours for 1948 includes $25,952,000 for new work and $76,042,000 for maintenance of existing navigation projects and related work.

N.W

THE ENGINEERING JOURNAL

(Published monthly by The Engineering Institute of Canada)

November, 1946.—There are no technical articles in this issue which is devoted mainly to a list of members of the Institute.

An interesting report appears, however, on the *Commonwealth Conference of Engineers*, arranged by the three major British Engineering Institutions (the Civils, the Mechanicals and the Electricals) and held in London in September, 1946. It is gratifying to learn that there were no fundamental differences of opinion on any engineering subject.

December, 1946.—*Development of the Canadian Magnesium Alloy Assault Bridge*. This article describes a very light infantry assault bridge, all parts of which are light enough for one man loads over long distances in the jungle. The history is given from its inception early in 1944 to a demonstration in May, 1945. No component weighs more than 27 lbs. A single girder span of 100 ft. supports a live load of 100 lb. per ft. run. Four girders on a 50 ft. span will take two vehicles aggregating 19,000 lb. weight.

Welded-Boiler Locomotives on C.P.R. Lines. A general description is given of two welded boilers which have been in operation on the C.P.R. for over a year. The advantages resulting from welding in preference to riveting are explained.

Modern Practice in Activated Carbon Solvent Recovery Plants. Activated carbon is now produced on a commercial scale (developed in recent years in connexion with poison gas warfare) with an absorbing power eight times that of the charcoal formerly used, and its use in solvent recovery is effecting great economies in many industries.

Developing Professional Attitudes amongst Undergraduates. An address given in the University of Toronto on the subject of training for citizenship, which the speaker points out should not be lost sight of in any university curriculum.

January, 1947.—*Housing Problems and how "Housing Enterprises" is solving them*. The housing shortage in Canada is just as serious as it is in Britain and for the same reasons.

"Housing Enterprises, Ltd." is a private company (owned by the Life Assurance Companies) which was formed to provide houses for rental. 3,500 houses were built by this company in 1946. The company purchases former service camps and salvages materials therefrom, thereby minimizing delays due to shortages of new materials. The method of selecting tenants is described.

Naval Cables in War. The paper describes how industry has co-operated with the naval authorities in converting English cable designs to those suitable for Canadian conditions. Some manufacturing details are given. The principles of degaussing ships and of sweeping for Magnetic mines are described.

Utilization of Sydney Slags for Engineering and Agriculture. A paper describing the commercial uses of Blast Furnace Slag—including road building, cement, concrete aggregate, heat insulation and soil fertilizers.

Fuel Oil for Industrial Boilers and High Heat Combustion Chambers. The advantages of liquid fuel over coal are explained. Various types of atomizer are very fully and clearly dealt with and their relative advantages and disadvantages described.

W.M.

CORRESPONDENCE

TRANSPORTATION IN WAR

Brigadier *Sir* Godfrey D. Rhodes, *Kt.*, C.B., C.B.E., D.S.O.
c/o Sir Alexander Gibb & Partner, Consulting Engineers
P.O., Nairobi, Kenya.

20th January, 1947.

To The Editor,
The R.E. Journal.

Dear Sir,

It is agreed on all sides that modern war cannot be waged without adequate transportation facilities, suitably controlled to serve the needs of the Army Commander. The importance of this matter leads me to stress the need for a well thought out organization, planned on the largest scale and supported by comprehensive technical intelligence covering the whole world.

Some of the lessons learned from the first world war were quickly forgotten and there seems to be a danger that these lessons, re-emphasized though they were in the second war, may again be ignored.

It is recognized that on the conclusion of a world wide war special short term arrangements may have to be made to meet immediate requirements, but it is important that the future organization of transportation services and the method of their control should be carefully planned during the transitional period.

At the beginning of the recent war an attempt was made to create a combined Movement and Transportation Organization. Unfortunately, due, I, believe, largely to the lack of efficient planning and preparation before hand this embryo organization broke up almost immediately into its two constituent parts. While it cannot be denied that extremely succesful results were obtained in all theatres of war with this set-up, it will be agreed by many officers in both branches that the organization adopted caused many internal difficulties, with resulting grave loss of efficiency and economy both in personnel and in money.

Some of the more serious difficulties, seen from inside the organization, may be summarized as follows :

(*a*) A regrettable lack of cohesion and *esprit de corps* between the two branches.

(*b*) Duplication in many ways, such as :
  (i) The use of valuable technical personnel for staff duties, who would have been more suitably employed on technical Transportation duties.
  (ii) Both branches formed Intelligence, Planning and Personnel sections, which of necessity over-lapped in many directions, involving much waste of officers and men.
  (iii) Transportation services needed data and statistics for operating purposes ; " Movements " also required similar statistics for staff purposes. Frequently both branches insisted on collecting their own, so wasting time and men.

(*c*) Confusion in duties, due to " technical " staff officers and sometimes Transportation personnel carrying out Transportation services under Movement direction.

(*d*) A lack of efficiency in the use of Transportation services, and indeed sometimes even misuse, owing to the absence of co-ordination of both departments under a supreme head, resulting in a serious waste of transportation facilities.

(*e*) Complete absence of certain departments at Headquarters which would necessarily be provided in a joint organization such as a Movement and Transportation Accounts section, capable of handling all accounting problems of both branches, including the drawing up of Railway and Port agreements with civilian organizations and having authority to deal with the Treasury, where necessary. The latter department cannot be expected to have a full knowledge of the intricacies and details of Transportation accounting and financial policy.

(*f*) Due to the breaking up of the organization into two comparatively junior branches, Transportation problems frequently were considered at too late a stage in campaign planning, resulting in much wasted effort.

While it was agreed that none of the above difficulties in itself would lead to the failure of a campaign, together they led to much waste and inefficiency and created dissatisfaction among keen officers, which should be avoided in future planning.

With all this in mind, it is strongly recommended that Transportation services and Movement staff duties should be co-ordinated and controlled by a Director-General of Movement and Transportation, with the rank of Lieutenant-General, wielding a corresponding influence in Cabinet and War Council circles on all campaign planning. It is probable that a sufficiently qualified officer to hold this post would not be available in the Corps of R.E. One or more suitable civilians of the General Manager grade could, however, be ear-marked to fill such a post on the outbreak of war and to hold a watching brief in peace-time. There should be, in additon, a deputy Director-General with the rank of Major-General, who would be responsible for the administration of the organization in peace-time and who would act as deputy to the Director-General in War. Under the Director-General would be two Directors of the Major-General grade, one for Transportation services and the other for Movement staff duties. Serving both branches would be Planning, Intelligence and Accounts sections and in addition a Personnel section which would ensure the efficient use of every officer and man in the two branches.

It is suggested that an organization on this level will ensure :

(*a*) the earliest appreciation of and therefore planning for transportation requirements in war ;

(*b*) the maximum use of all personnel and consequent saving in highly valuable technical man power ;

(*c*) the Staff of the Army working through the Movement Branch would still retain the essential direction of the use to which Transportation is to be put.

Combined Movement and Transportation organizations would also be required in each theatre of war. In fact, such an organization did function in Mid-East but on unsound lines, as Movement staff officers were frequently employed on or directing Transportation service duties, with wasteful results. A similar organization was set up initially by Mid-East for Paiforce,

but was later amended by the latter Command to restore all Transportation services to the proper branch, leaving the Movement branch to attend to its proper function of staff duties. This amended organization worked admirably and gave complete satisfaction to the Army Commander. At the same time, each individual officer and man in both branches understood his duties and felt he was pulling his maximum weight. Incidentally, it may be stated that the same type of organization was adopted at Salonika and Constantinople in the first war and functioned equally satisfactorily. Such an organization is capable of serving purely military operated areas or purely civilian operated services, or any combination of both.

It remains to consider the relationship of such an organization to the Corps of Royal Engineers. Situated as we are, it is hardly likely that a case can be made out for a separate Transportation Corps. It is, therefore, recommended that the Department of Movement and Transportation should remain an R.E. responsibility under a specially trained officer, who, as suggested above, would automatically become Deputy Director-General when the war Director-General was appointed.

As regards the responsibility for the construction of both railways and harbours in war, it may frequently be convenient and economical in plant for the Engineer-in-Chief to be made responsible for much of this work ; he should, however, then act as a contractor to the Director-General, who would specify what work would be required and by what date. Unless this relation is clearly recognized, there is great danger that essential Transportation requirements would take second place to other works for which the Engineer-in-Chief would be responsible, leading to unfortunate results in the mobility of the Army.

As most of the personnel required in war would be employed in civil positions in peace time, it is essential that all such personnel should be registered on some national list for call up in war time. Some form of Special Reserve might be created for this purpose, which should include all the Colonies and Dominions and all suitably qualified Britishers serving elsewhere. The Army will no longer have the valuable training ground of India at its disposal and Longmoor and other similar training depots cannot possibly give the full time training that is required in what is after all a life-time job.

No attempt has been made here to work out the details of such an organization, nor, as stated above, is it likely that an organization of this kind would be required for the immediate post-war years. My experience and I believe the experience of many others during two world wars strongly supports the combined Movement and Transportation set-up, under a high ranking specialist officer, and I suggest that an intensive study should be made of this important problem during, say, the next five years, before the lessons of the war are forgotten, in order that the future war organization may be suitably designed to give maximum results.

Yours faithfully,

G. D. RHODES,
Brigadier.

Lately D.Q.M.G. (Mov. and Tn.) Paiforce and formerly Director of Railways Salonika Army and Army of the Black Sea.

PRE-STRESSED CONCRETE

Lieut.-Col. H. H. C. Withers, D.S.O., R.E.
No. 8 T.B.R.E.,
Halleaths Camp,
Nr. Lockerbie.

7th April, 1947

To The Secretary,
Institution of R.E.

Sir,

I have been very interested to read the articles on pre-stressed concrete in the recent issues of *The R. E. Journal.*

It may be of interest to the Corps to know what I believe to be the first use of pre-stressed R.C. beams in the U.K. was in the Corsham project, at the Monkton Farleigh Works, while I was D.C.R.E. there at the end of 1939.

A very large number of beams was required for a span of about 17 ft. and to take a load, if I remember rightly, of about 1 ton per ft. run. In order to save steel R.C. beams of normal design were considered, but their size and weight ruled them out. I therefore suggested to the then C.R.E. (Lieut.-Col. A. Minnis) that pre-stressed beams should be investigated. On his agreement I got in touch with Dr. A. Mautner to whose design some pre-stressed beams were made for test purposes. These beams were about half the weight of, and showed a considerable saving of, steel over normal R.C. beams.

The tests, at which the Chief Engineer of the Ministry of Transport and representatives from the Ministry of Works and from the B.R.S. were present, were very successful, with the result that a contract was given for the Monkton Farleigh Works. I understand that a large number of stockspan beams were also made for the Ministry of Transport at various centres for use in case of bomb damage to bridges in this country.

Unfortunately I was posted away from Monkton Farleigh before work was in full swing, but I heard later that owing to changes of plan only a small proportion of the contract was ever completed.

Yours faithfully,

H. H. C. WITHERS.

SPECIAL NOTICE

The fact that goods, made of raw materials in short supply owing to present conditions, are advertised in this magazine should not be taken as an indication that they are necessarily available for export.