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Photo 1.—The scroll in its wooden frame.

The Freedom Of The City Of Ripon 1

THE FREEDOM OF THE CITY OF RIPON

By LIEUT.-COLONEL M. C. A. HENNIKER, D.S.O., O.B.E., M.C., R.E.

ON 27th July, 1949, the Freedom of the City of Ripon was conferred upon the Corps. It was a great occasion, marking the climax of nearly ten years association between the City and the S.M.E.

Early in the week the S.M.E. took possession of the Market Place. From dawn till dusk men toiled with hammers and chisels, crowbars and spanners, to make an arena worthy of the event. Flagstaffs, stands for the City Council, a saluting base, and seats for the public were the fruits of their labour. These were decorated with flags, and the citizens of Ripon improved the occasion by hanging bunting and flags from every conceivable window, nook or cranny in the town.

Such were the outward signs of preparation. Behind the scenes, though, other preparations were in progress. Officers and Other Ranks drilled and rehearsed ; the square resounded with the tramp of feet ; swords, rusting in their scabbards, were drawn anew and burnished ; movements, long since forgotten, were revived to make the sword drill of the officers perfection ; soldiers toiled into the night with " blanco " and metal polish ; their wives and girl friends were pressed into service to mount their medals on brooches ; and staff officers and clerks burnt the midnight oil over their desks and typewriters. It could truly be said that everything that wit or foresight could suggest was matched by equally strenuous endeavour.

This tremendous labour deserved a fine day and received its deserts. The day was fine. In the morning the City Council met in the Town Hall and passed the following resolution :—

" That the City Council being desirous of recognizing and fostering the intimate association existing between the Corps of Royal Engineers and the City do hereby confer the Freedom of the City upon the Corps, together with the privilege, honour and distinction of marching through the streets in the city on all ceremonial occasions with bayonets fixed, colours flying and bands playing."

Satisfied that the first step had been well taken the councillors and their friends proceeded to the Barracks. They were met by the Commandant S.M.E., Brigadier B. C. Davey, and presented to the Chief Royal Engineer, General Sir Guy Williams, the Engineer-in-Chief, Major-General A. D. Campbell, and other distinguished R.E. officers. The proceedings then took a more convivial turn. The Mess Staff did their bit ; drinks were served, followed by an excellent lunch.

Lunch over, the assembly, by a miraculous piece of staff work, were wafted back to the City in cars and buses. By this time a large crowd had gathered in the Market Place, the Corps Band was playing light music and the representative parade of 250 soldiers from all branches of the Corps had assembled. The Chief Royal Engineer, the Commandant S.M.E., and the Commander Ripon Wing, S.M.E., Colonel C. E. A. Browning, and Staff took up their appointed places. The Cathedral clock chimed two and the ceremony began.

The Mayor, Alderman F. C. Lowley, and Corporation, in full regalia, emerged from the Town Hall. They were confronted with a double line of soldiers from 24 Field Engineer Regiment between which they walked in state to their stand behind the Council Table. The R.E. Trumpeters from Aldershot, in full-dress uniform, sounded a fanfare ; the Union Jack and the Corps flag were broken at the mast head ; and the Chief Royal Engineer formally received the Mayor and Corporation.

The Officer Commanding the parade, Lieut.-Colonel D. R. M. Orchard, ordered a General Salute, which was taken by the Chief Royal Engineer and the Mayor. The C.O. was presented to the Mayor and the Guard of Honour was inspected. As the Chief Royal Engineer and the Mayor went down the ranks of the Guard of Honour they were preceded, at the slow march, by two officers with swords at the carry. There is no doubt that the people liked this display. In the heart of every Englishman there lurks the idea that the British Army officer enshrines something of the magnificent. In the drab days of battle dress this something is lacking. But here, with drawn sword and a chest-full of medals was the genuine article.

Next, the Mayor took his place at the Council Table and spoke as follows :—*

" General Sir Guy Williams, Officers and Men of the Royal Engineers, may I, on behalf of all the citizens, extend a hearty and sincere welcome to you on this, one of the greatest days in our very long and, we trust, honourable history.

" Ever since your arrival amongst us in 1940 you have shown a willing and ready desire to help this district in any way within your power. The country was passing through its darkest days when you came and immediately we found extraordinarily willing co-operation with the local Anti-Invasion Committee, which at that time was organizing and planning for the safety of our citizens in what appeared to be a most real threat of invasion. Mercifully those plans were never required to be put into operation through the efforts of our country's armed forces, of which your honoured Corps played so large and distinguished a part. We remember your great assistance and expert guidance with the problems of air raid precautions, the facilities and co-operation shown to us during our War Savings Campaigns. We shall never forget the services so willingly given by your Corps Band ; we in Ripon have a very soft spot for the R.E. Band. We were fortunate to have it stationed here during the war years and were very grateful for the cheering performances given week after week in our Market Place and Spa Gardens, when the country had precious little to be cheerful about.

" When the war ended your co-operation did not diminish. We shall not readily forget the demolition of the air-raid shelter in the Market Place—destroyed and cleared in record time, the incalculable assistance given to our Housing Committee by the mechanical excavation and levelling of our housing sites at Gallows Hill and Holmfield, and our young citizens will play on better recreation grounds by your efforts at Camp Close and your desire to do what you can to restore Quarry Moor. We have appreciated your hospitality at the camp and the facilities granted on many public occasions, your ready participation that has helped to brighten many a civic parade, and we do not forget the excellent and enjoyable exhibitions by your staff of eminent artists.

" These are but a few of the kindnesses shown to us and I should never be forgiven by the citizens if I failed to pay an adequate tribute to the well-mannered and courteous behaviour of all ranks of the Royal Engineers at all times during the past nine years.

" Your men of all ranks have joined wholeheartedly in the life of our City; religious, cultural and sporting organizations have all cause to be grateful for having known you. Is it any wonder then, that we are anxious not only to say ' Thank you ' but to *do* ' Thank you ' and to place on record for all times the deep bond of fellowship that has grown up between the Royal Engineers and the City of Ripon ?

* Extract by permission of the *Ripon Gazette ond Observer.*

"We in Ripon are conscious of witnessing a great occasion and writing another page in the history of the City—we are not ashamed to say—we love. We feel that Ripon has some grand old customs and traditions and we know that we are adding still further to them today, and not the least to be gained by us is the lesson that I hope our young citizens are learning today, and that is the great value of tradition and pride of inheritance.

"We trust that in the years that are to come, as our young people grow up and see a detachment of the Royal Engineers accompanying the Mayor on Mayor's Sunday, they will remember that it perpetuates an honour earned by the courtesy and integrity of a section of a great Corps stationed here from 1940 to 1949, and we trust that the whole Corps of the Royal Engineers throughout the world, wherever they may be stationed, realize the honour and affection that has been bestowed on them by the efforts and actions of the section we in Ripon have known so well.

"In order that we may all be aware of the meaning and significance of 'The Freedom' I feel that it will do us all good to hear again its history and origin."

At this point the Mayor said it was a hostile act to march through any city or town with fixed bayonets, as it meant the act of a conqueror.

He recalled that since Cromwell's time standing armies had been abolished, and it required, as it did to this day, an Army Act to be passed each year to justify an army being maintained at all. The conferring of the Freedom of a City was the highest mark of confidence that the people of a town could show a regiment in allowing it to march through with fixed bayonets, so great was the townspeople's confidence that there would be no treachery caused by putting themselves at the mercy of the military.

"In short," resumed the Mayor, "it means that we trust you implicitly and are happy to have you as friends.

"We have, this morning, unanimously passed a resolution conferring the Freedom of the City on the Corps of Royal Engineers, and an illuminated copy will be handed to the Chief Royal Engineer for safe custody, and we are happy to know that it will be deposited in our Cathedral. We hope that if ever the day comes that duty takes you from this district you will call upon us for anything that is in our power to give.

"We wish you the best of good fortune and success in the future ; we shall follow your career with great interest—and bask in your reflected glory—and we trust that we in Ripon will so act that you will always be proud of your close association with us.

"We know that the resolution we have passed carries with it no privileges and no perquisites, for we have not the power to grant them—but we do know that it carries with it the goodwill, gratitude and affection of the whole of our citizens, and that the granting of the Freedom of the City is the highest honour that we have the power to bestow."

This done, the Town Clerk read out the deed and the Mayor presented the parchment to the Chief Royal Engineer who signed the Roll of the Freemen of the City of Ripon on behalf of the Corps. The deed was put into its wooden casket and taken back into the ranks by the Escort under an officer.

The Chief Royal Engineer then addressed the assembly. He said :—*

"You have conferred today a great honour on the Corps of Royal Engineers in granting to our Corps the Freedom of your famous, ancient and honourable City. As Chief Royal Engineer I ask you to accept our thanks. It is the first Freedom granted by your City to any arm of the Services, and we are indeed proud to hold this unique distinction. We can now say that we actually belong

* Extract by permission of the *Ripon Gazette and Observer*.

to the oldest borough in England (save York), dating back to its Royal Charter and famous horn of A.D. 886 and to its even older Cathedral. Little did your City think that it would add to its ancient industries of wool, spurs, saddle-trees, varnish and paint, and that its main product for the last ten years would be that of turning out the modern sapper trained to handle the latest devices of science for use in war. You have been equally successful in that product as you were in your old-established industries.

"During the war, 4,000 officers and 35,000 men passed through the School of Military Engineering in Ripon, and were trained in the multi-farious duties of our Corps—for example, bridging and road-making, building construction and water supply, airfield construction and bomb disposal, mine laying and lifting. The young Sappers trained in Ripon went to war and put the knowledge they acquired to good use in defeating our enemies in every theatre of operations throughout the world. Both war and training for war are a noisy business, and your citizens, and the surrounding land-owners, have been subjected for years now to explosions which have shaken their houses and disturbed both man and beast. In fact the Sappers may almost be said to have usurped the functions of your City Wakemen.

"There was of course, too, the inevitable damage to land and property; disfigurement of the landscape by bulldozers and graders, and the rumbling of heavy mechanical monsters, driven at Army speed, through your ancient and narrow streets, which were built for the pleasant days of horse transport, long before the invention of the internal combustion engine, the real source of all our present-day troubles. Added to the noise and danger of these modern diabolical contrivances, the citizens of Ripon were subjected during the war to a large influx of strangers, not only British, but also Americans, French, Belgians, Poles and other Allied nations, attending the S.M.E., and wanting to share your accommodation and enjoy your civic amenities. All these disturbances have been borne with much tolerance, and the invaders have been received with hospitality and kindness. You have helped the families of our Sappers in their domestic difficulties; our canteens have been staffed by the ladies of Ripon; and our men and their families owe a debt of gratitude to your doctors and nurses. There has also grown up a most friendly rivalry in sport between the City and the Garrison.

"All the kindness shown to us in the long years of the war has endeared the City of Ripon to the Corps, and the grant today of the Freedom of your City is a crowning event for us.

"The granting of the Freedom of your ancient City, Mr. Mayor, shows that the regard the Corps has for Ripon is reciprocated by its citizens; and we of the Corps of Royal Engineers shall ever cherish and be proud of this signal honour which you have conferred upon us. On behalf of all ranks of the Corps of Royal Engineers, I thank you for the gift of the Freedom of your City."

When the Chief Royal Engineer had finished speaking, the C.O. of the parade advanced to the Mayor and said, "Sir, may the Corps of Royal Engineers have the privilege, the honour and the distinction of marching through the streets of your City with bayonets fixed, drums beating and bands playing?"

The Mayor replied: "Yes, by the virtue of the granting of the Freedom of this City to your Corps, I give you permission now and on all future occasions to march through our City with bayonets fixed and bands playing."

The C.O. then gave the order to fix bayonets. Another general salute was given and the troops marched off "with bayonets fixed and bands playing." The line of their march led them past the saluting base where the Chief Royal Engineer and the Mayor took the salute. As the column neared the

Photo 2.—General view of the parade.

Photo 3.—The Mayor of Ripon inspecting the Guard of Honour with Lieut.-Colonel D. R. M. Orchard, R.E.

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Photo 4.—The Mayor of Ripon presenting the scroll in its casket to the Chief Royal Engineer.

Photo 5.—The casket.

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Cathedral the bells peeled forth a greeting ; thus ending the ceremony with the Church's benediction.

Formality then gave way to lighter sentiments. Tea was taken by the senior officers in the Mayor's Parlour while the Corps entertained a number of guests to tea elsewhere.

On Sunday, 31st July, the scroll in its casket was deposited in the Mallorie Chapel of the Cathedral. The scroll was later placed in a frame and left in the custody of the Dean and Chapter. The casket will go to Chatham.

A description of the scroll, frame and casket was given in the *Ripon Gazette and Observer* and is, by permission, quoted :—

The scroll, which is in vellum, is the work of Mr. J. Porteous Wood, R.S.W., of Ripon, who also designed the casket and frame. It is embellished in full colour and gold with the arms of the Royal Engineers and the Ripon crest at the top. The words " City of Ripon " stand out in raised silver and gold. The address—" To the Chief Royal Engineer the Officers and Other Ranks of the Corps of Royal Engineers " is in the regimental blue. The main body of the text is written in black and red. It reads :—

" Greetings. Whereas We the Mayor, Aldermen and Citizens of the City of Ripon in the West Riding of the County of York being sensible of the great record and glorious traditions created by your distinguished Corps over many years of loyal and devoted service to our beloved King and Country and being desirous of recognizing and fostering the intimate association existing between us have this day conferred on you the Freedom of our City.

" Now we do by these presents grant you the privilege, honour and distinction of marching through the streets of the City of Ripon on all ceremonial occasions with bayonets fixed, colours flying and bands playing.

" In witness whereof we have caused our Corporate Common Seal to be hereunto affixed this Twenty-Seventh day of July, One thousand, Nine hundred and Forty-nine."

It bears the City's Seal and is signed by the Mayor of Ripon and the Town Clerk.

Mr. Wood served in the Corps during the war.

The casket and the frame are the work of Mr. John Thorpe of Ripon, a grandson of a former mayor and mayoress, the late Mr. and Mrs. Richard Thorpe. The casket is of English oak and has carved on the lid the badge of the Royal Engineers and the Ripon badge connected by a chain, both badges and chain gilded and painted in the appropriate colours. In incised lettering is the date. " Ripon, 27th July, 1949."

Underneath the lid is a Yorkshire rose, which is Mr. Thorpe's trademark. At the front is a brass escutcheon. The frame, also of English oak, has carved in the centre at the top the Royal Engineers' badge painted and gilded, while in the background on either side is a Bailey bridge with a tank at each end. In the background are trees and a small Cathedral all carved in relief, with a Yorkshire rose at each end. At each end of the bottom is the Yorkshire rose, and in the centre the Ripon badge carved in relief and coloured. On the left-hand side is a representation of the Cathedral carved in relief, and on the right the Town Hall. The side columns are fluted.

After witnessing all this the R.E. officer may feel disposed to ask, like Little Peterkin, " What good came of it at last ? " The answer is no easier to give than on the field of Blenheim. Perhaps it would be true to say that this ceremony was the token of long years of discipline and courtesy on the part of the Corps, tolerance and understanding on the part of the citizens. When the hard-headed people of the North open their hearts to the Corps, in a way they have done to few others, it makes one realize what an honour it is to wear a Sapper cap-badge. Surely this alone makes all worth while.

THE ASSAULT AT ALAMEIN

By BRIGADIER G. R. MCMEEKAN, D.S.O., O.B.E.

INTRODUCTION

THE campaigns in the Western Desert had a very good press at the time, and there have been many excellent books by war correspondents and others. The sapper activities have been less generously covered in the *R.E. Journal*, so perhaps the following purely personal account of a battle may be of interest. It was written whilst recovering from injuries, when the church bells of England were being rung to celebrate the victory, with the vague idea that in the twenty-first century someone might like to read about great-grandfather in one of the Great Wars. Much of it sounds very naïve now, but it must be remembered that many tactical and technical methods were then new to the Army, and still newer to me, who spent the early part of the war besieged in Malta.

The story opens when I joined 10 Armoured Division as C.R.E. in the autumn of 1942, ignorant, as we all were, that the date of the attack had already been fixed for twenty-four days hence. After the defeats of the summer, Eighth Army had been re-organized, re-equipped and re-vitalized. Its new Commander, General Montgomery, had beaten off what was to be Rommel's last threat to Egypt. Morale was excellent.

TRAINING

The division was in bivouacs, training for the attack, on a nice quiet piece of desert about fifty miles behind the southern end of the Alamein line. We were fifty miles from water, which was rationed to a gallon per man per day. Half of the gallon went to the cookhouse ; the man could do what he liked with the rest. But though the sand penetrated everything one owned, desert sand is clean and comes off easily. With a careful batman one could manage a clean quart of water daily to wash in, with an extra quart now and again for a "bath." This quart remained all day in the basin, covered to protect it from driving sand. The soap suds were skimmed off before the evening wash, after which it was again allowed to settle till morning. Another skim, and it was carefully decanted, leaving the sediment of sand, into the inevitable petrol tin, where it accumulated until required for washing clothes. After that it went once more through the skimming and sedimentation process before consignment to its ultimate destination, the radiator. One learned to keep the elbows well in when washing the neck, to avoid loss by splash.

With raw troops, life would have been most uncomfortable, but with the well-seasoned Yeomanry, who had rumbled up and down the Western desert for two years, we were almost luxurious, as they had nothing to learn about the siting and digging-in of bivouacs, the art of desert driving, and the innumerable uses of the petrol tin. The modern tinned ration is not sybaritic, but everyone keeps remarkably fit on it in the clean air, except for the lamentable desert sore. This affliction only incapacitates if it is neglected, but it seems inevitable after six months in the desert.

When units were stationary, messing was by troops. It was not practicable to concentrate larger numbers for any purpose by day, when individual vehicles were always kept at least 100 yds. apart owing to the air threat and lack of cover. In mobile operations the crew of each vehicle drew and cooked its own rations, using as a stove a petrol tin of sand soaked with petrol. This applied even to the officer and one driver in a Jeep. The water ration was often further reduced, sometimes down to half a gallon a day.

The division included the 8 Armoured Brigade (Brigadier Custance) which had started the war as horsed Yeomanry, and the 133 Lorried Infantry Brigade (Brigadier Lee). The Divisional R.E. was composed of:—

2 (Cheshire) Field Squadron. (Major Perrott)
3 (Cheshire) Field Squadron. (Major Moore)
141 Field Park Squadron. (Major Carr)

All these units had sprung from the 2 Cheshire Field Squadron, the only Field Squadron to exist in the T.A. in peace. All three were short of men, owing to casualties and to the number of overheads required to maintain a unit in the desert, so we only mustered about thirty-six working numbers per troop.

Although we did not know it then, General Montgomery's plan for the attack had already been worked out to the last detail. Unit training on the required lines was in full swing. For the sappers of an armoured division this training was being directed, firstly, to the clearing of mines and booby traps; secondly, to tank or gun busting; and, thirdly, to the desert craft essential to all arms—navigation by day and night, alarm drill, leaguering and so on.

The second of these needed the least thought, as it followed naturally on the other two. But it was necessary to ensure the closest co-operation with other arms, as the derelict tank or gun was to be expected in the large areas of No-Man's-Land normal to desert fighting, anything from one to ten miles across. At dusk, both sides would send out a small mixed force, to recover or destroy as the case might be. Often a small battle developed, and the sapper needed an escort on whom he could rely. When distances were greater, minor operations of this sort were undertaken by day, and artillery cover was needed, as well as armoured cars or tanks.

Desert craft could be taught by our normal mode of life, training as we were far from roads and water, in country devoid of landmarks.

The problem of mine clearance, therefore, occupied nearly the whole of our attention. The enemy position at Alamein had been developed for three months. It was well dug in, and well covered by wire and mines. At least half the mines were British, lifted from the enormous fields at Mersa Matruh and elsewhere. The defences had considerable depth, 3,000 to 5,000 yards in most places, but there were no anti-tank ditches and no concrete pill boxes.

The last time I had been in a field unit was in the mid-thirties, when the infantry hoped soon to get an elephant gun to protect them from tanks; when the R.E. Board was said to be hatching an anti-tank mine, and we used lumps of wood to represent them on manœuvres; when anti-personnel mines and booby traps would have been considered unsporting; and when minefields on this immense scale had never been dreamed of, nor the possibility of having to breach them. I was, therefore, extremely lucky to have Major Moore as a Squadron Commander, as he had been the first Commandant of Brigadier Kisch's Mine Lifting School, and had evolved the gapping drill in use throughout the Eighth Army.

I was told to work out a battle drill to clear four routes by night through two main belts of mines; 2 Field Squadron was to be kept back to go through with the armour at dawn; 571 Army Field Company—which joined us a few days later under Major Yeates—was to be under my command for training and for the break-through operation.

We did not know where or when the attack was to be. The armour wanted gaps 40 yds. wide, as in soft ground the leading vehicles churned up the sand so badly that those following needed space to avoid the worst

patches. To clear gaps of this width would have been a slow business, and unfortunately our first night exercise was held in one of the softest pieces of desert I have met, and confirmed their claim. However, the Divisional Commander by now must have known more than we did, and upheld my contention that with resources available, the best plan was to go for 16 yds. in the first instance, and widen later. Events proved this width to be enough on the good going at Alamein.

We worked out a detailed scheme for this, and tried it out on another night exercise. We could just manage it, but every available sapper was deployed from the outset. I was much relieved to hear that a second Army Field Company was to be allotted us. This was the 573 Company, which had recently been bridging the Nile, and which was very rusty in its mine technique. They arrived under Captain Longman, with only a week to go, as it turned out, before we moved forward. Their new Commander, Major Brinsmead, I only met as we were marching to the assembly area. I felt they were our weakest link, but Brinsmead took hold of that company in magnificent style, and they did very well on the night.

The night exercises, with the whole Armoured Division co-operating, were of the greatest value. One squadron would be detailed to lay mines in a certain area—unarmed. Next night the attacking squadron would send out recce patrols to locate the leading edge. The night after that was the exercise proper, and the sappers, led by their recce parties, located the mines, cleared, marked and lit the gaps. Meanwhile the Military Police traffic people marked the approach route with lamps every hundred yards or so, and Signals laid their telephone cables to every gap, at which a staff officer was located to control the traffic. We had our own infantry covering parties to protect us while we worked.

At about 0400 hrs. our work would be done, and it was an inspiration to us to see the armour, which had formed up behind us meanwhile in the dark, in close formation, flowing and roaring through, nose to tail, in three columns only a few hundred yards apart.

The lifting of mines is a comparatively simple business in daylight when not under fire, but even then, it requires a strict drill, and constant practice. Every man must recognize every type in use by the German, Italian, French and British Armies, and know how to immunise them. He must search below and around each one lest there be a booby trap wire attached. He must never take a step without looking for mines or trip wires. An exact drill must be followed if 100 per cent of the mines are to be found and lifted in the gaps marked. If casualties occur, spare numbers must be at hand to replace them instantly ; every man has to know his neighbour's job.

We trained on moonless nights, in the desert starlight. The first problem was to locate the leading edge of the field, which was generally unmarked. Recce was done by patrols on previous nights. They returned with an intimate knowledge of landmarks like derelict vehicles, old wire fences, shell holes and so on.

On the night of the breach proper, units were led up on foot by guides. The division was to go through on a 1,000 yds. front for its four gaps, so errors of navigation were not permissible. Accurate compass bearings and pace measurement sufficed, but they had to be made at 2½ miles an hour without pauses.

Behind the guides came the marking party, who carried tapes to trace the gaps. Behind them the detector parties, with their brand new instruments. These were very scarce during training, but great efforts were made at home

and in South Africa to fly them out straight from factories, and we had just enough in the end. An alternative method of mine detecting is by prodding ; a line of men advance, stabbing with their bayonets. This employs rather more men, and they are perforce a concentrated target.

Behind the detector parties come others for neutralizing and lifting the mines ; and for marking the safe lanes. This is done with single strand fence, on the pickets of which are hung small electric lamps, shaded from above, ready to be switched on for the armour—green to the lane and amber to the minefield. Every torch battery in Egypt had been requisitioned, but there was always a dearth owing to their popularity with the troops.

A reserve party is provided on each lane for spare numbers, stretcher bearers and runners. For a 16 yds. lane through a field 400 yds. deep, sixty men are a minimum—two troops being about right at our strength. If there is a further field to breach beyond that, transport must be provided for the extra fence stores, as all the men are laden.

It was the business of the Military Police to mark and light all routes except actually in the minefields. Often the approach route was ten miles or more, and this work had to be done after dark, requiring good navigation and intelligence on the part of junior N.C.Os. and men. We used to lay a tape behind us through No-Man's Land for them to follow us accurately in the battle zone.

The Army Plan

From about 7th October, the plan of attack began to be unfolded to us. At first, the location and boundaries, but not the date, were disclosed to Brigade Commanders and C.R.E. only. We badly needed all sorts of information about our particular piece of front, but in order to preserve the secrecy which was essential, we had to get it without disclosing the location to anybody.

In fact, the issue of all necessary information to everybody concerned at the last possible moment was one of the greatest achievements of Eighth Army Staff. The enemy was deceived, and information did not leak out. Yet, when the time came, everyone knew not only exactly what he was to do, but also what the Army Commander's plan was, and the importance that his own part played in it. In the meantime it was tantalizing to know but to be forbidden to go and look.

The plan, briefly, was as follows. Four infantry divisions of XXX Corps were to make a night attack on the northern front, just inshore of the coast road, with the object of securing a bridgehead on the far side of the main enemy defences through which the main armoured force was to be thrown. The frontage was only a couple of miles for two armoured divisions—the 1st and 10th, reinforced in each case by an additional armoured brigade. These two Armoured Divisions, with the New Zealand Division, formed the X Corps, which was the heavy punch. The X Corps was to pass through the bridgehead and establish itself astride the enemy communications, amidst his gun line, to await battle on ground of General Montgomery's choosing.

The XIII Corps and various French, Polish and Greek units were to attack on a much wider front, in order to pin the enemy infantry to his ground and to invite dispersion of the enemy armour.

The enemy forces were slightly inferior in numbers, and had only about two thirds of our gun power and half our tanks. They were known to be getting short of petrol, food and ammunition, and they had eaten up the great stores captured from us during the July retreat. Their morale was still high after their victories which had brought them so close to the Nile.

The R.A.F. had, by October, achieved definite air superiority. Our troops had their tails right up, thanks to the offensive spirit inspired by General Montgomery from the moment he took command. We were well fed, fit and confident.

Tactically, we had been defeated in June and July by allowing our tanks to be drawn into prepared gun positions. It was now intended to break the crust in a single night and to establish the armour in an area where Rommel would have to attack us to reopen the supply routes to his troops to the southward.

It was my job to clear the routes for my division, through the bridgehead formed by the New Zealand Division. The latter, in order to achieve surprise, were not to disclose themselves before sunset, and no amount of juggling could get them across the start line before 2200 hrs.

This left us only eight hours of darkness to clear the mines and wire in their wake, *and* for the armour to pass through—2,500 vehicles I think it was. The programme was ambitious, and permitted us only half an hour more than the theoretical best possible, even allowing for the infantry to reach their objective to the minute. Had we succeeded in keeping to our time-table, the Africa Corps might well have been completely eliminated at Alamein. The Army Commander, in setting this extremely difficult task, saw to it that every man knew not only his own part but also the whole plan in outline. Preparations were made for a fortnight's dog-fight, and we were to carry seven days' rations and water on the vehicles. General Montgomery told us that with our superior morale, numbers and resources we should wear out the enemy providing no stupid mistakes were made. And so it was to be.

The deception plan was interesting. Cairo and Alexandria were buzzing with gossip during October. Everyone talked of the attack, but no one knew when and where it was to be ; leave for officers and men went on as usual up to about a week before the day, and even then no one was recalled. At the same time, all officers down to Company Commanders were told of the plan, and Commanding Officers were collected for an address by the Army Commander. After that, no one was allowed back to the Delta " except on a stretcher." The decision not to recall men off leave was nearly disastrous in my case, as the excellent Scottish radio operator on my armoured car missed the battle, and his substitute was an indifferent performer who failed in the crisis.

The active deception measures included numerous ruses. Tracks for the assembly of the armour in the north were duplicated further south. Our tanks and guns moved by night to an assembly area previously occupied by the lorries of divisions in the line ; dummy lorries were set down in their place, like canvas garages, into which the tanks drove on arrival. Before dawn we had obliterated their tracks by dragging harrows around, and fresh wheel tracks were made. A whole brigade of dummy tanks was made up on old lorry chassis with canvas bodies. These manœuvred about as if on training, and finally drove, silent but flapping, down to the south.

These measures undoubtedly succeeded. Rommel expected an attack in the south, about a fortnight later.

Preparations for Battle

From about 13th October on till zero on the 23rd I was so busy attending conferences that I rarely saw my troops at their training, as the various Corps and Divisional H.Q. were widely separated. Our own Divisional R.E. conferences and " O " Groups used to gather after dark in a blacked-out Ford.

About 14th October the divisional plan took definite shape. I was to command a task force to clear routes for the armour ; the composition was :—

3 Cheshire Field Squadron R.E. (Major Moore)
141 Field Park Squadron R.E. (Major Carr)
571 Army Field Coy. R.E. (Major Yeates)
573 Army Field Coy. R.E. (Major Brinsmead)
Det. Div. Signals (telephone laying to the gaps)
Det. Div. Provost (to mark and light the routes up to the gaps)

No protective infantry were provided by our division, as it was necessary for us to press close on the heels of the New Zealand assaulting infantry.

The task force was to move on day D — 7 to an assembly area on Bombay Road, about fifteen miles behind the front ; from there we were to do our detailed recce and to liaise with the Highland Division in the line, and the New Zealand Division.

On 16th October I was at a conference at Corps H.Q. at Burg el Arab, where Lieut.-General Lumsden was propounding his plan. We were told the date of the attack, 23rd October, and I realized that the task force should have moved that morning (one of the only two instances of bad staff work.) The march of seventy miles or so was over particularly bad going across country, and was to have taken two days. I managed to get a signal back ordering the march to start next morning, and to be completed in one day. With Driver Hughes I got back to what by now was home at about midnight, and we all set off next morning. The going was shocking, and though the better found squadron vehicles made it in the day, some of the field companies spent the night on the way.

The 2 Field Squadron remained behind with the 8 Armoured Brigade, whom it was to accompany through the gaps we made. The 6 Field Squadron R.E. joined the division about this time with 24 Armoured Brigade, with the same rôle as 2 Squadron.

The two field companies were to revert to corps control as soon as the gaps were cleared, and I, with the 3rd and 141st, was to go on with the division, resuming command of the 2nd and 6th in addition. All this was complicated, and I had only the normal Adjutant (Scott) and Intelligence Officer (Alesworth), plus a few D.Rs. and clerks on my H.Q. I realize now that I should have insisted on extra officers and D.Rs. for liaison.

To return to our movements. By the afternoon of D — 6 (18th) the whole of the task force had arrived at the assembly area. We now encountered the second staff blunder : when I arranged for R.E. patrols to motor up the fifteen miles to Alamein after dark each night, and to go out across No-Man's-Land on foot to recce our front, the Highlanders in the line objected strongly, as, to prevent leakage of information through casualties or captures in the enemy minefield, they had orders that no member of X Corps was to be allowed forward of our wire. In fact, the New Zealand infantry and sappers were likewise prohibited. We did manage to get patrols out the first night, conforming to our own divisional orders, but after that it was stopped. The whole object of our early move was defeated, though we obtained some benefit from going up to our forward positions in daylight and peering through glasses.

The front was quiet. One could motor up safely to the crest a few hundred yards behind the front trenches, provided one used a Jeep or truck. Staff cars, or a bunch of officers with maps on the skyline, were liable to attract a few shells. Our infantry, scattered in section posts, each several hundred yards apart, moved about quite unconcernedly in daylight, cooking, washing or working. About a mile away one could see the enemy doing the same.

At dusk the artillery exchanged a few bursts, but by day one heard nothing but a shell or two at random every half hour or so.

The New Zealand Division, with whom we were to go through, was a very fine one. But detailed co-ordination was not easy owing to the distance between Divisional H.Qs. in the planning period. We were to suffer from this when their infantry were held up in the attack on one flank and we had to discover it the hard way ; also when their medical organization missed our casualties.

About a week before the battle, both the New Zealand Division and ourselves were sent three " Scorpions." These were the first of their kind, and were old Matilda tanks fitted with a revolving drum on a bracket in front, on which was hung a number of short chains. These flailed the ground and set off the mines. The drum was rotated by a Ford engine bolted to the *outside* of the tank. The engine was housed in a very light steel box, which also contained a sapper to drive it. The R.A.C. crew were inside the tank in the normal way. Volunteers had been called for from R.E. units for this hazardous task, and we had produced our quota.

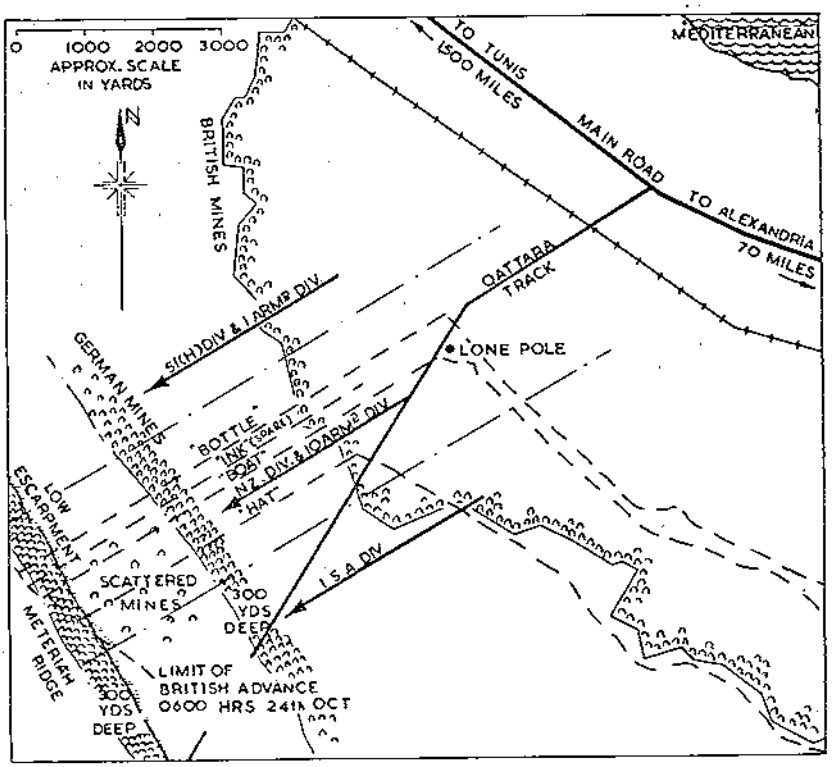
The " Scorpions " had various limitations. Their speed when beating was only 1½ m.p.h. ; after about 400 yards of it they boiled and had to stop ; they raised a terrific dust, so that the sapper in his box could see nothing and had to wear his gas mask. We had no time to train with them, so General Gatehouse arranged with General Freyburg that our three " Scorpions " should work with those of the New Zealand Division on the opening night, provided that all remaining runners should go forward through the gaps with us.

On 22nd October the troops were told the plan. I assembled all officers and N.C.Os., and passed on all that the Army Commander had told us at Amirya the week before. I told them that they were about to take part in one of the decisive battles in history ; that the fighting would be ferocious and would last about ten days before the Germans cracked ; that we sappers had to ring up the curtain for the armour ; that we were better equipped and better trained than any British attacking force since 1918 ; and that I considered myself lucky to be there, and was proud to be commanding them.

All this they passed on to the troops. It was not possible to collect numbers of men to be addressed by C.Os., so all these harangues had to be passed down and the final discourse was given by the subaltern to his men. The whole Army did it, and there is no doubt that in consequence morale was magnificent, for the will to win was universal, and we all felt ready for anything. A Squadron Commander said afterwards : " The battle was won before we started."

I was also careful to point out that the barrage would be heavier, on our own front, than anything ever put down before, even on the Hindenburg line. Ten of our guns were to concentrate on every known enemy gun position. Therefore, the more noise the better. I am sure that this was the most comforting thought to everyone who walked forward on 23rd October.

On the morning of the 23rd we trickled forward the fifteen miles to our forming-up place in groups of three or four lorries at a time ; the vehicles then went back empty. In order to preserve secrecy, we were only allowed to retain a minimum of vehicles to carry lane marking stores and tools—each squadron one Jeep and two lorries only. One of the latter was sandbagged to act as a pilot vehicle over the minefields. In addition, I kept my own Ford car as a sort of office (as it could be blacked out), a Jeep for messages, and the armoured car which carried the wireless. Wireless was forbidden until the armour had punched through, but I was empowered to break silence in emergency.



SKETCH SHOWING 10 ARMD DIV. ROUTES 23RD OCT. 1942

The allotment of engineers to the four lanes was :—

" Bottle " route (right)	573 Army Field Company less one Platoon.
" Ink " route (spare gap)	3 Fd. Squadron plus one Platoon 573 Field Company.
" Boat " route	
" Hat " route	571 Army Field Company less one Platoon.
Reserve	One Platoon 571 Field Company. All available sappers 141 Field Park Squadron.

This reserve, under Major Carr, was to follow C.R.E. on " Boat " route.

By about 1700 hrs. we were assembled near a solitary telephone pole on the Qattara track, south of the railway, about four miles west of Alamein Station. The New Zealand infantry had filtered up like us, and their vehicles had gone back. Troops were very thick on the ground, and before sunset everyone took the opportunity to cook a hot meal. It was an unforgettable scene. Thousands of little groups, each gathered round their petrol tin fire, some men taking their boots off, some writing home, some sleeping. In spite of this enormous and dense concentration of 30,000 men or more in an area of perhaps three square miles, the enemy never spotted us. There was a quiet hum of conversation, but no shells, no bombs, no lorries even.

I felt that every possible preparation had been made. Some of our equipment—detectors and armoured trucks for the exploiting squadron—had only arrived three days before. But we had almost everything we needed —men, tools, transport—and this feeling of being adequately equipped for

the task is very rare in war. Moreover, as a sapper problem it was simple—to sweep the mines. Even the last minute intelligence was excellent—maps which showed all the landmarks and minefields, every derelict tank, every bit of wire.

The Attack

At 2000 hrs. the leading tanks of the 8 and 24 Armoured Brigades on our sector, and those of 1 Armoured Division on our right, had begun rumbling along to form up behind us, with the gunner late-comers, thickening up the battery line after dark. Most unfortunately the evening breeze was far from the usual quarter of north-east ; we all realized that the enemy, a couple of miles away, could hear them. The gaff was blown, but too late for effective defence arrangements to be made. Still no shelling.

There was about a mile to go to the start line, and at 2100 hrs. the New Zealand infantry quietly collected their equipment and disappeared. Their advance was to be slow, and I reckoned we could give them forty minutes and catch them on the first enemy minefield. So the start of the barrage at 2140 hrs. was to be a convenient signal for our own move ; this was to get us to the start line thirty minutes after zero, with about another mile of No-Man's-Land to cross before the first enemy mines.

The opening of the barrage was grand. Since the enemy had not yet fired a round, we felt everything was going our way. As we started from the gun line, the noise was deafening. What impressed me was that it just went on all night, and did not die away after half an hour. It literally soothed us, and one could ignore the enemy shell fire, trivial by comparison, which came on us later.

We were all waiting ready to set our watches at the barrage ; and at once the R.E. recce parties led off, followed by the tape men, detector parties and the rest of us. I rode on the roof of my car, in order to see the troops, as far as the start line. There we paused for ten minutes, then on again through our own minefields into No-Man's-Land. From there we took only the one pilot vehicle per gap, the others waiting till called up. It was full moon, and in the desert that means you can see single strands of wire before you fall over them.

C.R.E's. headquarters followed immediately behind two troops of 3 Squadron on " Boat " route, which was the main divisional axis. Behind us was our little reserve party, accompanied by our Regimental Aid Post, which was intended to consist only of our doctor and one orderly, on foot, who were supposed to be tied up with the New Zealand organization. The doctor, who had only a few months' military service, brought his ambulance along in defiance of orders. I heard afterwards that it took a bullet in the petrol tank, and as he failed to make contact with any medical unit for some hours, he gathered one or two lightly wounded men as orderlies and set up a first-aid post which dealt with dozens of cases throughout the night. Even so, many serious casualties had to lie out all night ; our division had an ambulance column all ready, but owing to the breakdown in communication we never managed to summon them.

After about twenty minutes I knew we had reached the first enemy minefield. There was some machine-gun fire just in front, and the tracer bullets began to zip across in front of us. It was clear that the infantry fight on the outpost line was not over. The men in front halted, but this would occur in any case while the recce party was doing its job. The pause lasted fifteen minutes, and I began to get restive and walked on for news. About this time the first shelling hit us, but did not amount to much. We saw our first prisoners—three Italians, very shaken by the barrage—guarded by

three sappers, looking very fierce with bayonets. I could not afford sappers for this sort of thing, so the escort was reduced by two-thirds.

Before I had gone 100 yds. the line in front advanced again, and I soon found 3 Squadron starting to sweep the first minefield. The delay had been caused by the pilot vehicle being hit and catching fire, illuminating our men as they formed up. This attracted a volume of machine-gun and mortar fire, but in face of this, a gallant little party, led by the Squadron Commander, managed to extinguish the blaze with the aid of some Pyrenes off other vehicles.

The clearance of the first minefield began at 2320 hrs.—twenty minutes late. I moved the armoured car up to it, and sent runners out for news of the other routes. Signals arrived to lay the telephones, both along the routes and laterally. But the shelling increased, and the lines kept getting cut. We never succeeded in getting phone communication of any value all that night.

In the moonlight, one could see many of the mines ; they were not deeply buried, and the wind had blown the sand off them in many cases. In the lanes cleared that night no mines were missed, and none were touched off by the thousands of vehicles which churned their way through until they were axle deep in dust. In the face of enemy fire, which was to increase greatly on the second belt, the sappers worked steadily on, keeping to their drill. The long nights' training were amply rewarded. It takes guts to stand up, and stay standing up, under heavy fire, when everyone else is either running forward or lying down. But our men were so wrapped up in their job that I don't believe they stopped to think about it.

Around midnight I found that the two Provost lorries on our route had both been hit by shells, about 100 yds. back. I went along and found some of the reserve R.E. party pulling wounded men out. Among them was a Provost Lance-Corporal, who was the only unwounded survivor. He was busy extricating his C.S.M., in charge of the party, and others. I got hold of him and told him that as the only man left he must get on with the job, and that I would give him sappers for the work, and would look after his wounded. He immediately pulled himself together, asked if he had reached the first minefield ; said in that case he could do without the disabled lorry, but would need a driver and four sappers for the other. I didn't see him again, but the route *was* marked and lit all the way by dawn. The Lance-Corporal was one of the many on whom decorations subsequently fell.

I then spent some time collecting news, by runner and intermittent phone, from the flanks. Meanwhile 3 Squadron on my route had advanced again to the second field on the Meteriah ridge. They sent back their S.S.M. in a Dingo (Daimler scout car) to report progress. He arrived on foot saying he had driven over a mine between the known fields ; this meant an unmarked and unknown " indiscriminate " patch of mines, over which our forward infantry and sappers had moved without spotting it. I organized the reserve party to deal with this, and to widen the gap in the first minefield. What with casualties and replacing the police, that about used up the reserve for the time being.

I have never understood how the enemy managed to leave unmarked minefields *behind* his outpost line. It is true that he did not use his M.T. at night to bring up rations, etc., so far forward as we did. We never laid a minefield without some sort of notice or trip wire, except in front of our foremost positions. Perhaps he had notice boards which were removed on the alarm going.

All this delayed me, and it was not till about 0200 hrs. that I was able to start forward again. I decided to take our H.Q. vehicles forward—armoured

car, Jeep and Ford—as time was getting short and it was obvious that we could not rely on the phone for communications. I sent back for the cars, but the Ford failed to turn up. Driver Gosmore afterwards reported that he had been digging himself a slit trench when a bullet glanced off the shovel and punctured the tyre. Another went through the dash-board and my "unbreakable Thermos," recently purchased at great price.

I led the way in the armoured car, followed by Lieutenant Alesworth, with his faithful Driver Crump, in the Jeep, which was sand-bagged as a precaution against mines. I gave a lift to the S.S.M. and to Lieutenant Hague (I think it was) who as recce officer, had done a complete tour of his squadron area and of part of the German side of the ridge, and who had come back to report. These two clung to the back of the armoured car, and the Jeep, for protection, clung to our tail. At the last minute I picked up a corporal of 3 Squadron who had been tending wounded. He had to ride on the mudguard. (We were worried about our wounded, being afraid they might get run over when the armour surged forward ; I had them carried to one side, but had to leave fighting men with them lest the stretcher bearers should fail to find them in the dark.)

We had about 1½ miles to go. I soon saw New Zealand infantry digging in ; not a good sign, as they should have been further forward. There was quite a bit of shelling, particularly from some low trajectory weapons whose shells ricocheted off the ground, which was growing rockier as we neared the ridge, and burst in the air about 6 to 10 feet up.

I told the R.E. corporal to try and get behind the turret with the other two ; I was standing, with the R.A.C. corporal who was in charge of the armoured car, in the turret, with my head out to see what was going on. Behind me the S.S.M. pointed out his Dingo, which had lost a wheel on a mine. Its driver had dug himself a hole alongside and was waiting for the Light Aid Detachment. At this moment my head burst, and I fell about a mile through space. Death didn't seem to hurt, and I stopped falling gradually.

The fact that my chin was resting on something hard and cold made me realize that I was alive. Moreover, I was quite unhurt, though there was a tremendous roaring in my head and I was distinctly unbalanced.

The sapper corporal was badly hurt by numerous splinters, but nobody else was injured. Some New Zealand Infantry came over and helped apply first field dressings. I did a part faint, but a minute on the ground, with my head between my knees, put me absolutely right. Cure was completed by a sup from Alesworth's flask. Found that my right ear was bleeding a little, and also my right arm. Applied dressing to a small hole in latter. To our surprise, the car was still a runner and the tyres were undamaged ; so it was an air burst or ricochet shell that nearly hit us—not a mine as we first thought.

We went on, through another 1,000 yds. of broken ground, to the Meteriah ridge. There was some wire, and both New Zealand and enemy dead. One German caught my eye, from the way he lay on his back with one knee bent up. He made a convenient landmark alongside "Boat" track. The shelling was by now considerable.

We found 3 Squadron report centre under a bank, a few yards short of the second minefield on the ridge. The cars were tucked away under this bank. It was 0330 hrs. and the armour was due to start through at 0400 hrs. We had been delayed by various mishaps, and it was vital to report back to Division. Major Moore turned up ; both his gaps, "Boat" and "Ink", were nearly through. It was not till later that I realized that the sappers on

this route were at that moment working ahead of the assaulting infantry, and that they were within 200 yds., in some cases, of the harassed, but unbroken, defenders.

About this time I managed to get through one of the very few phone calls. Signals had run a line to the right flank, and before it was cut by shell fire I got a report from Brinsmead of 573 Field Company that "Bottle" gap was through. But I could get no news from "Hat" on the left, so I went to find out in a Jeep, taking my direction roughly from the setting moon. I drove, with Driver Crump beside me. After a few yards a bayonet whistled up against the side of the car. I realized that the Maori behind it had been most forbearing; owing to shell deafness I had not heard his challenge, and failed to stop. I changed seats with Crump, and after another 100 yds. some more Maoris roared at us. Crump said—"They say we've already run into a minefield." We found a warning trip wire wrapped around our back axle. Then I saw what we were looking for—some sappers of 571 Field Company. Near them, on the edge of the ridge, was the trip wire, and there was a gap in it marked by a board with a skull and cross bones and "Achtung Minen!" This was just where "Hat" gap was to have been made.

The Sapper Sergeant in charge of the half-dozen men taking cover behind the bank explained that this was their recce party. The rest of the company were some way back, still clearing one of these damned unmarked and unexpected minefields. They had been over the ridge, and put up their guiding light on the far side, and on the correct bearing. But they had done no clearing. Their recce officer had gone back to report. I asked why they had not used the existing Boche gap, clearly defined by a wire fence and fresh tracks, even if it was not in the proper bearing. He said he didn't know.

By now I realized that there were no infantry in front of us, and that they had failed to gain their bridgehead beyond the ridge. The armour was due shortly, and with three other gaps duly swept, there was still time for them to get through this one if a way had been cleared for them behind us; and if we could guarantee the German gap. The recce party had a "pram" detector on bicycle wheels, so I called on them and Driver Crump to push the pram and do a quick check-up for mines laid after the last enemy vehicles through. In the moonlight we ought to be able to see any laid in the last hour or two.

About six of us started off through the gap on foot. Two men with the pram in the centre, the rest of us lined out on either side, looking for fresh marks in the sand. There was a good deal of light calibre shelling, and intermittent bursts of machine-gun fire. I was so imbued with the urgency of our mission that I had no time to be windy, though I remembered to keep a man glued to the least deaf ear. We went about 150 yds., and were over the crest. Had we known it, we were within 100 yds. of the far side of the minefield; the exit was covered by a strong point which was to hold out for two more nights; we lost many good men there, but never got through until the whole line broke.

Then two machine-guns opened up directly at us from what seemed to be 200 yds. away to our left. It was obvious that we were spotted, and that there was no time to complete our recce by crawl, so I turned back and headed a dignified retreat.

It seemed to me, at 0430 hrs., with another ninety minutes before sunrise, and with three gaps swept and marked and a fourth enemy gap clear for at least half-way over the final minefield, that I would be justified in calling the armour on. At that moment I felt all Africa was within our grasp, if only

the tanks could be shepherded through within the hour. I went back to "Boat" gap in order to report to Division. I found my little H.Q. tucked in under a bank just short of the ridge, trying to open communications by phone, but the lines had all been cut again. This was obviously the moment for me to break wireless silence. But the set in the armoured car was off net; apparently my fall had shaken both the apparatus and the operator. If only Signalman McKay had come back off leave. . .

It was maddening to know that the whole plan might fail because the news could not be sent back. But after a few more minutes' struggle with the dead phone, someone said he could hear the armour rumbling up. Normally one could hear them miles away, but owing to the barrage they had come within a few yards of us before we heard them.

I jumped in the Jeep again, and rushed back down "Boat" track. We met the leading tanks very shortly—I shouted to the Squadron Commander that his route was clear. Close behind I found Brigadier Custance, Commander 8 Armoured Brigade; the situation was soon explained, and he passed my news back to Division on his wireless. He said that the left column on "Hat" route had got through the uncharted field and were level with him, but were uncertain of what was in front of them. I said I would go across and guide them.

This involved a diagonal journey, starting from my landmark of the German with his knee crooked up, between the two marked routes, and I feared we might hit a mine. Foolishly I neglected to take a compass bearing, thinking I could keep my direction from the setting moon. But the ground was broken, with trenches, wire and gun-pits, and although we had only 300 yds. to go, I suddenly felt lost, until I saw that there were two glows—rising sun and setting moon. I suppose I was a bit hazy; anyway it seemed ages till I located the tanks, which had halted.

To my disgust they said they had orders to halt. This was in accordance with the Army Commander's policy, which forbade rash attacks by tanks through defiles in the face of enemy artillery. But in my impatience it seemed folly to lose the chance before sunrise. So back I went to the Brigade Commander.

We soon found our gruesome landmark, but this column too had halted, and tanks and guns were pulling off the track. There were only a few minutes left before sunrise. I asked a gunner for Brigade H.Q. He demanded my identity card—which I produced, fretting at the delay. A few seconds later a gunner subaltern again asked for the card, and this time it fell from my hand, which was quivering from rage and impatience. Lt.-Col. Packard, Commanding 1 R.H.A. turned up at this moment and took me to the Brigadier. But it was no good. The leading tanks, some preceded by O.C., 3 Field Squadron on foot, had been knocked out as they debouched over the ridge on "Boat" and "Bottle," and the whole division was held up.

Sorrowfully, I went forward to my Tac. H.Q. The ridge was hotting up, and our own artillery was still pounding away as it had done all night. Close behind us 1 R.H.A. were coming into action. The enemy was shelling us persistently, and bullets were ricocheting off the ridge over our heads. The R.E. had done their work and there was no point in exposing unarmoured troops in that hell. I gave orders for them to withdraw to the original enemy front line a mile or so behind, where we could reorganize and summon our transport.

Troops were so thick on the ground that it seemed impossible that the enemy shells could fail to hit something every time. But casualties were, in fact, not heavy. I remember noticing a shell burst about 30 yards away, and

thinking that had I not happened to be facing it, I should never have noticed it.

We found Major Carr, with his reserve somewhat depleted by casualties, had finished widening and marking the "Boat" gap on the first field. We stopped there at about 0700 hours, and the inevitable brew-up followed. I sent messages to units to widen the other gaps on this field, as there was no shell fire back there now. Had there been more time, I might have switched the reserve party over to "Hat" route; but without phone they would not have been moved there before sunrise.

About this time, just as I was enjoying some tea and bully and biscuit, General Gatehouse roared by with his Tac. H.Q. in three Crusaders. The General, looking larger then ever in his white sheepskin coat and black beret, was sitting calmly on top of his tank. He went right up to the ridge, and toured round to see the situation. It was an encouraging sight, and a well-timed visit.

The Ford had now been recovered, and I jumped into it and followed the General to make my report. But the ground was pitted with trenches, shell holes and wire, and we struggled for some time before we actually caught up. He confirmed my order to extricate and reorganize the Squadrons which had done the sweeping.

By this time the dust was appalling, particularly in the narrow gaps in the minefields. In places one could not see ten yards, and one was in danger of collision in broad daylight.

I then issued orders, about 0800 hrs. to withdraw 3 Squadron to the original No-Man's-Land, to reorganize for the next night's work. The two Army Field Companies came back to the original starting point, and took over the widening of the swept routes in the more rearward zone. Later in the day they reverted to Corps command. Meanwhile, our transport rejoined and we were mobile once more.

My H.Q. went to rejoin Main Divisional H.Q. now close behind our starting point, in the original gun line, whence the mediums were still pounding away near Alamein station to the east of Sydney Road. On the way I saw 2 Squadron, who, like the 6th, were to have exploited with the armoured brigades. They also were held up, in old No-Man's-Land. I saw our "Scorpions," or rather the three, out of the original six, which had retained their mobility. Their officer explained that one tank had been knocked out, and two damaged. The others needed repair, but he hoped to get them going in a few hours. Carefully noting his location, I told him to stay put, and promised to send orders when I knew the next plan.

About midday I went off to visit the two Army Field Companies who were at work still widening the rearward gaps. Neither of them had suffered many casualties, only about fifteen between them. They told me that the delay to 571 Company on "Hat" route had been due not only to the unexpected minefield between the two main belts, but also to a small enemy post with a light automatic which was still in action and had not been mopped up by the second wave of infantry when they arrived there. The Company Commander had to deploy some of his mine-clearing party to deal with it, and, having arranged some covering fire from rifles, was about to lead a charge when the enemy caught sight of the second wave of Maori infantry who were coming forward silhouetted against our gun flashes. To the relief of the improvised assault party, the post then surrendered. Meanwhile Lieutenant Darwell had led his recce party past all this, right up to the Meteriah ridge, and had found the enemy gap about an hour before I did. He had managed to get right through the minefield on the correct bearing, i.e., a little further away from the strong point which spotted us, and had

put up his guiding light on the further side of the field. Perhaps it was unnecessary to clear a complete new lane when one already existed which would have brought the tanks out within 100 yds. of where they planned to be, but it was a brave deed, which indicates also the high standard of desert navigation to which we had trained.

Over on the right, 573 Company had a much better passage on "Bottle" route, but here again they had ended up on the ridge in front of our infantry; the completion of their task had been achieved under the fire of two machine-guns which were methodically traversing; the officers, watching the tracer, shouted to the men to drop as it swung towards them. Further beyond them the Highland Division had perhaps encountered thinner defences and made a deeper penetration than on our front. Consequently, the 1st Armoured Division, although held up, was echeloned forward of us.

At 1530 hrs. the Divisional Commander held an "O" Group. The situation was that 8 Armoured Brigade were close up behind the ridge, which they could not cross in daylight; 24 Armoured Brigade were behind them, restricted by the forward enemy minefields, which they were astride. The 133 Lorried Infantry Brigade were in the rear of them again. Nowhere on the Eighth Army front had the enemy put in any sizeable counter-attack, though small pockets of Panzers had come into action and been driven off with ease.

Crouching almost in the General's lap I was just able to hear his orders, which were to the effect that 8 Armoured Brigade were to make a limited advance that night (24/25th October) through the gaps already cleared, and were to secure the Meteriah ridge. The 24 Armoured Brigade (Brigadier Kenchington) were to come up diagonally on their right in order to reinforce the success achieved by the flanking divisions. It was thus hoped to get the armour of both 1 and 10 Armoured Divisions clear of minefields and ready for battle by dawn 25th October—a little short of the original Corps objective. The Lorried Infantry Brigade were to secure and consolidate the bridgeheads on Meteriah ridge in order to act as a left pivot for the armour. For this operation the 2 and 6 Field Squadrons were to remain under the command of their respective Brigades.

It was obvious that the task of the 24 Armoured Brigade was one of the greatest difficulty, as its line of advance started diagonally across the routes we had cleared and marked, and was to finish up well to the north of the zone we had all studied so carefully on the map and from intelligence summaries. They were to advance about 5,000 yds. during the night and there was little daylight left for preparation or reconnaissance. The difficulties were discussed, but General Gatehouse said there was no question of the Army Commander varying these orders. Before dispersing at about 1620 hours I promised Brigadier Kenchington to send over one troop of 3 Squadron to support 6 Squadron, together with reserves of mine clearance gear. 6 Squadron would then be able to allot one troop for each of three lanes and to have a small reserve party. I also arranged with Brigadier Custance to send up the remaining "Scorpions" to help 2 Squadron in their frontal attack.

As soon as I had implemented these decisions I went over to see whether there was anything further I could do for Major Collins with his 6 Squadron. It was their first battle and I felt distinctly apprehensive about their ability to complete their task. There were only three hours left to make their preparations, so I soon wished them luck and got out of the way, returning to Divisional H.Q. via 2 Squadron, who had the very simple but dangerous task of proving the existing gaps, which probably by now had been sealed off on the far side under the noses of an alert defence. It was obvious that

the "Scorpions" might be the perfect answer, as they could be lined up under the bank which had sheltered us and given an exact distance and bearing on which to flail, covered by a terrific concentration of artillery fire. By the time I left, the "Scorpions" had not yet arrived to join 2 Squadron in answer to my message. On the way back I looked for them, but could not see them where I had left them. It was dusk, and the clouds of dust reduced visibility to a few yards, so I thought I must have missed them on the way. On arrival at H.Q., however, I found that a D.R. had also failed to find them and that wherever they were they had not received my order. It was now dark, and although we phoned everyone we could think of, we had no news of them until about zero hour, when somebody said he had seen them four miles back at Alamein Station during the afternoon.

The Second Night

Although all the sappers were deployed on mine clearance again during the night 24/25th October, the situation was too confused, and the troops were too dispersed, for me to take any active part during darkness. I had, therefore, to play a passive rôle at Divisional H.Q., and also had some sleep. Some progress was made by the division during the night, and the success gained on the right was further exploited, whilst the enemy strong point on "Hat" route still held out and blocked us on that flank. 2 Field Squadron had one troop each on "Ink," "Boat" and "Hat," and a recce party went forward down each lane as soon as it was dark. On "Hat" Captain Hattersley was caught by a machine-gun half-way through the field—our old friend again. He was killed by a bullet in the head, and the sapper with him, who was wounded, was captured by a German patrol, which was probably covering a party laying new mines on the exit. The sapper succeeded in escaping during the confused fighting and re-joined his unit the following evening, but at dawn on the 25th all we knew was that the recce party had not returned.

On the other routes of this squadron the gaps were proved and the Infantry made some progress. Unfortunately some of the Notts Yeomanry transport, crowded up at the entrance to one of the gaps, caught fire. A colossal blaze followed on the ridge, which illuminated our troops and lasted several hours. It also attracted the fire of every enemy gun that could bear; and a number of night bombers also joined in. Operations on "Hat" and "Boat" were held up for the rest of the night, but I believe the Infantry reached their original objective on "Bottle," linking up with the Highland Division on our right and taking possession of that part of the Meteriah ridge and its minefields.

Just before dawn a report went round that the enemy had pulled out on "Hat." Lieutenant Sage, a young officer who had come up to take over Captain Hattersley's troop, went forward to find out, and to try and locate Hattersley. He soon found the report to be false; the sapper with him was killed, and he was hit in the leg by a sniper. However, by crawling backwards for some distance watching for sniper's heads and generally snooping around the minefield on his belly, he partially completed his recce, and returned with valuable information after a 400 yds. crawl, much of it in daylight.*

6 Squadron, with the 24 Armoured Brigade, had been partially successful in their difficult task. Movement had been very slow, but the blaze on 8 Brigade front had distracted the enemy's attention. Dawn found them well forward, though a little short of the objective ordered. 6 Squadron had made some lateral gaps to link up with "Star" route on 1 Armoured Division

* There were a few anti-personnel mines in these fields, but not in the quantities encountered later in the war.

front, and by some freak had come through the first twenty-four hours of battle without a casualty.

I have not yet heard the story of the infantry attacks on this night, either by our Lorried Infantry Brigade or by the New Zealanders. I can only record here what I saw, or heard at first-hand, at the time; this emphasis on purely sapper activities implies no failure to appreciate the very gallant actions which were being fought all round us by other Arms.*

The rearward gaps had been widened by the Corps Troops sappers, and the diagonal advance had enabled the troops to disperse a bit on our sector. Even so, there was a good deal of traffic—ammunition going up, tanks being salvaged, prisoners and wounded coming back. The dust was worse than ever, and the enemy had brought up some reserve artillery and was pounding steadily away. The R.A.F. had almost grounded the Luftwaffe, but not quite, and on this day they must have received reinforcements. We saw a number of dog fights and there was some bombing, though not enough to bother us. In any case, I was impervious to battle noises, though the hearing in one ear was beginning to improve.

About midday on the 25th the search for the "Scorpions" was still unsuccessful, so I arranged for a broadcast appeal over the wireless—"Anyone finding three 'Scorpions' to report location immediately to 10 Armoured Division. Last seen Alamein Station." Another eight hours passed before we heard that all three "Scorpions" had in the end been evacuated for major repairs; some message had gone astray; it was never necessary to write out the charge sheet which at one time I was mentally preferring against the officer in charge of them.

The Dog Fight Continues

The close, heavy fighting was to continue for a further nine days before the final break-up of the Africa Corps was achieved. The troops were fighting or moving all night and every night, and often much of the day as well. Our division was withdrawn to the original start line one night in order to re-group the army and to reinforce still further the success gained on our right by the Australian and Highland Divisions. Gradually the task of the sappers turned more to widening and improving existing lanes rather than assault breaching. In the end it changed yet again to tank busting, and in the gallop forward to Mersa Matruh one squadron recorded over 200 before the order was received to salve them for scrap rather than destroy them. But, alas, I missed the pursuit, as long before it started I was a guest of the R.A.M.C. back in Alexandria, heartened however by a special Order of the Day on 27th October, 1942, by G.O.C., 10 Armoured Division, of which the following is an extract:—

"The present operations have only just begun and much serious fighting lies ahead of us. Normally congratulations would be kept until later, but I am particularly anxious that all Commanders in this magnificent team should make it known to all under their command how their energy, skill and determination in these early phases, and under most arduous conditions, are appreciated . . .

"I particularly wish to commend the very gallant and efficient work of the Royal Engineers, the Royal Corps of Signals, and the Corps of Military Police. These troops led the advance of their Division under shell and small arms fire, and in my opinion the mines were lifted, communications were established and the routes were marked with the same precision and efficiency as in our training schemes in the rear areas."

* This still applies in 1949. I have never found any complete account of the actions on our front.

"GO TO IT"

THE STORY OF THE 3rd PARACHUTE SQUADRON, R.E.

(continued)

By MAJOR J. S. R. SHAVE, M.C., R.E.

CHAPTER 6

THE ARDENNES AND HOLLAND

RETURN FROM NORMANDY

One came home from Normandy with mixed feelings. Blissful thoughts of reunion with those at home, tinged with regret for the ones who were not returning with us, the ones who lay in France from Ranville churchyard to the Seine.

After a pleasant twenty-four hours in the Liberty ship *Empire Gauntlet* we reached Southampton on 7th September, a miserable day of steady drizzle. A civic reception awaited us and seemingly our train was unable to leave until it was over. I rather sympathized with the organizers of the reception, since the weather spoiled the effect and everyone was a little fed up with having to wait around for a meal to the accompaniment of music played by a brass band. Eventually the meal was over, and having accepted a food bag for the journey, we boarded the train and set off for Bulford.

Within a few days the whole unit was off on a fortnight's leave, after which we paid serious attention to the business of re-equipping and training.

At the end of September a dinner was held at the "Bath Arms" in Warminster; all officers of the 3rd Squadron attended. Having toasted "The King" and "Absent Friends," we heard a few words from Rosie, who admirably expressed many of the thoughts which were uppermost in our minds at that time. He recalled "Tim" and other old comrades, and the fine record they had acheived. He thanked us all for helping the squadron through the campaign and expressed our determination to do equally well in the next operation.

After our parties at Warminster, there was invariably an argument as to who should drive the truck home. A 3-ton lorry was used to carry us all and I am certain it was never passed on the road by any other vehicle. Several officers in the squadron rather fancied their hand at the wheel—thank heaven there was very little traffic along the road at that time of night.

FIGHTING IN BUILT-UP AREAS

The months of October and November were spent in hard training, we were given definite lines to work along and simply told "get cracking." Most of the division went through courses of street fighting at the various "schools" sited in the blitzed areas of Battersea, Southampton, Yarmouth and Weymouth. In addition to this, as Sappers, we had to concentrate on the destruction of pillboxes, heavy wire obstacles and all obstacles one would expect to find in defended localities in built-up areas.

Using 249 Field Company as enemy, the C.R.E. set an exercise for the Para. Squadrons which involved most of the problems of our new work. The exercise was named "Heron" and took place in some lovely country just south of Blandford in the New Forest. The chief things I remember from

that scheme are, the bitter cold of a wet night, the attack and subsequent destruction of several pillboxes at dawn, and a small rafting operation. There was no doubting the value of that most uncomfortable day and night since we all learned a considerable amount about the difficulties facing us in this sort of task.

Shortly after this came a large-scale airborne exercise involving the whole division. Exercise " Eve " took place quite near Oxford, and for it we had to use airfields north of London, since those in the south were all operationally committed. On 18th November, 3rd Brigade moved by M.T. convoy to a transit camp at Wimbish in Essex. The air move was timed for the 20th, but owing to rough weather it was postponed until the 21st.

The 20th proved to be quite an amusing day all round. When it was finally decided that the drop could not take place on that day, Brigade H.Q. organized a route march in which all troops had to take part. On this march we found ourselves well to the rear of a long column of marching parachutists. At one point there were some Italian prisoners of war working in the fields and I presume that the chaps all the way up the column had been hurling " ruderies " at them. At all events, we were greeted by a shower of newly-cut swedes as we passed the spot. A massacre of a dozen excited " Wops " was narrowly averted.

On the 21st the drop took place at Appleford, near Oxford, and was quite pleasant. After a day of battling in and around the villages, we were picked up by our transport and taken back to Bulford.

At Appleford, the landmark for the " DZs " had been the river Thames. This fact, and our training for fighting in built-up areas, began to give a good indication of where our next operation would be. The conclusion we reached was that the place was to be somewhere across the Rhine in the Ruhr, we were never officially told, but I believe the actual site was Bonne. Other events intervened and the operation for which we had trained so hard never took place, little of the training was wasted however.

In addition to the street fighting and assault demolition training, the divisional engineers were all given a short bridging course at the School of Military Engineering in Ripon. The Para. Squadron followed 249 Company up there, and we were in the middle of the course, on 20th December, when we received orders for a quick move back to our base—the 25th December saw us on the sea.

Christmas, 1944

On Thursday, 21st December, 3 and 591 Para. Squadrons were at Ripon doing their Bailey bridging, when they received sudden orders to pack up and move to Bulford with all speed. We had been following the progress of events in the Ardennes as closely as we were able to from the Press reports, and so we were not greatly surprised at receiving these orders. On Saturday, 24th, we found ourselves in a train bound for Folkestone and on Christmas Day we embarked. All ranks had a Christmas dinner in the transit camp before shouldering full equipment " Marching Order " and marching down to the jetty. The last time I had seen Folkestone pier was when I met a cross channel steamer in the summer of 1937. The scene had been colourful and cheerful on that occasion, with the " Boat Train " standing by to rush passengers to Victoria. On this occasion it was damn cold and we were not so cheerful—web equipment is designed to " brown one off " very quickly, and we were no longer the green troops we had been on D-day.

A few hours later we disembarked at Ostend, many chaps slipping as they stepped off the gangway on to the icebound cobbles of the quay. Crammed

into trucks, we were driven some thirty miles east to the small village of Vichte where we were to await the arrival of our transport which was coming from Tilbury as a vehicle party.

The Flemish inhabitants of Vichte proved most hospitable and families competed with one another to find us billets. I will gloss over the next three days during which we were fêted as liberators (I think these folk were more than a little apprehensive of the success of the German offensive and visualized the return of the occupation—however, they did not show this). The village contained several weaving factories and the houses of the better off were filled with beautiful linen. On the 28th, the Burgomaster gave a dance in our honour in the local village hall. We felt very guilty about all this at such a critical time, but without our transport we were useless to the army so we enjoyed ourselves.

Another memory of Vichte dates from our first arrival there. Approaching a very French-looking Belgian, I inquired "*Parlez-vous Français Monsieur?*" "Yes," he replied, "I am a cockney born in London and stayed out here after the last war."

On the 29th December, Frankie turned up with our transport. After profuse thanks and the exchange of photographs and addresses with these kindly Belgians, we left Vichte early on the morning of the next day. After a long and bitterly cold journey across the length of Belgium, we approached the river Meuse near Dinant. In this, the American sector, the roads were choked with huge vehicles rushing men and material to the front. All day and half the night, we tussled our way through convoy after convoy, eventually pulling up in a clearer area at St. Gerrard west of Dinant. Here, at 2 a.m., we billetted in a large empty château.

The 31st was busily spent in organizing our stores and in doing various road recces east of the Meuse. We did not forget to celebrate the New Year with the one bottle of Scotch at our disposal. We gathered round this bottle in a small room upstairs and at midnight Freddy Fox proposed "The women we love." There were several misty eyes: quite a sentimental occasion.

JANUARY 1ST–10TH

On New Year's Day, the squadron spread out across the Meuse, each troop to a separate task, all of which related to bridging. No. 1 Troop to construct a 60-ft. double-single Bailey bridge across the river Lesse on the site of a demolished bridge at Vignee near Ciergnon. No. 2 Troop to take over the maintenance of a large Bailey constructed by 612 Field Company at Houyet. No. 3 Troop to construct a 50-ft. Bailey over a railway, again on the site of a demolished bridge at Vignee some 200 yds. from the No. 1 Troop site.

It was an uninteresting period on the whole, dominated by the local engineer problems of bridging and of keeping routes open and as free as possible from the dangerous icy conditions prevalent. Nos. 1 and 3 Troops completed their bridges and No. 3 Troop proceeded to Eprave on the 6th January, with two sections of No. 2 Troop under command, to construct another bridge.

Our first mines were encountered on the 4th, when Sergeant Docherty and I lifted four "Tellers" laid at the ford across the Lesse at Lissoir, some three miles up the river from Houyet. Tom March accomplished a magnificent recce of some twenty-two demolished railway bridges. The main railway of the Ardennes ran through our area in Houyet and on to Dinant. The twenty-two bridges lay along the stretch between us and the Meuse; the railway disappeared into a hillside some 200 yds. down the line from Houyet. Into

this tunnel went Tom on a 125 c.c. motorcycle, armed with a 6-ft. expanding metal tape, an engineer *Recce Pocket Book* and a wad of " Demolition Recce Proformae."

Owing to the fact that bridges were down on all side routes, there was no way of reaching most of the railway bridges other than through the tunnels which constituted the major part of this line. It took Tom seven hours to accomplish the task, but he managed to do it in one day. He arrived back late in the evening, just about all in ; he had ridden back in the teeth of a snowstorm—beneath his coating of snow he was covered in soot and grime from top to toe.

We had been really cold several times during our long training in England and during the first days of the Normandy show when we tried to sleep without blankets. The month of January in the Ardennes taught us a thing or two more about cold. We had plenty of warm clothing and liberal rum issues, and needed them all. A rifle inspection was most unpleasant for the men, since their fingers stuck to the frozen metalwork of their rifles.

Squadron H.Q. moved twice during this period, first into a small château at Reux and then to the palatial Château Royale d'Ardennes, on the heights above the Lesse near Houyet. This magnificent hotel was still being run by a skeleton staff, and had been kept in full splendour by the Germans during the occupation. Unfortunately the squadron shared this place with a tank regiment who had arrived there first, so there was no room for the rest of us.

The roads were in a very dangerous condition and it was a common sight to see a jeep in the ditch, or a tank side slipping down a steep gradient. A slight touch on the brakes was often enough to send a jeep skidding for many yards. A cartoon in *Pegasus* showed a jeep wrapped lovingly round a tree, the caption read " That must be the A.P.M." ; the latter individual having had three mishaps recently. An example of this skidding took place at the site over which No. 3 Troop constructed their bridge at Vignee. Here the road ended abruptly in a gap of about 40 ft., with a straight drop of some 10 ft. to the railway below. On the night of No. 3 Troop's arrival on site, an R.A.S.C. jeep came crawling down the hill towards the obstacle, was waved to a halt, applied its brakes and gently slid 10 yds. to end bottom up, on the railway line. The occupants were unhurt, and R.E.M.E. were able to recover the vehicle next day.

At Houyet, the bridge across the Lesse marked one of the limits of the German advance ; it had been blown by American engineers in the face of the enemy. Several " soft-skinned " German vehicles lay nearby, " brewed up " and abandoned. Here the valley of the Lesse is steep-sided and wooded, overlooking all stands the Château Royale, at that time very lovely in its mantle of white.

An amusing incident occurred at Jemelle, a small village reported as held by the enemy. The 7th Battalion were given the task of clearing it ; a section of No. 1 Troop, commanded by Jack Nash, was attached to assist if necessary. Jack arrived early at the R.V., and thinking he had mistaken the spot he moved on a little ; upon their arrival, the battalion were surprised to find that he had liberated the village—with no enemy in sight.

The 5th Para. Brigade had a very unpleasant time while seizing and holding the village of Bure, on the road to St. Hubert. The attack was first put in by the 13th Battalion on 2nd January, but it was not until the 5th that the area was finally reported clear. Describing it to me later, Captain " Chris " Barlow of the 13th, told how the battalion advanced against withering fire in its first attack. One sergeant, a few yards ahead of him, " disappeared into thin air with a terrific bang," he presumed this to be the result of a direct

hit from a "Panzerfaust," used at high angle. Later, after the battalion had established itself in the village, there were "Tigers" wandering past battalion H.Q. At this time the tanks used to advance in twos or threes. In close country or in built-up areas, each tank would have a screen of black uniformed S.S. Panzer Grenadiers on foot around it, each man armed with a machine carbine.

The Squadron moved forward on 9th January, H.Q., Nos. 2 and 3 Troops into a château west of Rochefort, No. 1 Troop into the village of Lessive. Early next morning, No. 2 Troop joined 3rd Brigade in Marche, 5th Brigade were in the Rochefort area and 591 Squadron in support.

The 286 Field Park Company had established themselves in a château behind Celle. They had not returned from Normandy as we had, in fact they remained in the B.L.A. theatre on each occasion, when the rest of the division went home to prepare for the next operation. In this particular location, Jack Waters and Jack Hall were well "dug in," and as usual, their squadron had improvised excellent bathing facilities for those members of the division who could visit the location.

JANUARY 10TH–17TH

Along the road to Marche, No. 2 Troop encountered streams of traffic moving in each direction. The 53rd Division, who until this time had been in the front of the 30th Corps' drive, was being replaced by the 51st Division. "Going" was difficult, all roads were iced up, Bren carriers in particular seemed to be in difficulties. From time to time one would see Sappers spreading earth and gravel upon the roads, this was a continuous and monotonous task which fell to all Sappers in the Ardennes.

One of the first units encountered in Marche was 274 Field Company of 51st Division—old friends from the bridgehead in Normandy. Commanding them was Major David Jack, brother of our Allen Jack, the O.C. of 591 Squadron.

In conjunction with 51st Division, 3rd Para. Brigade was to advance eastward from the town, and preparations were being made with this object in view. The first main objective would be the important road junction of Laroche; the advance could take place as soon as the route was opened by Sappers. A Bailey was under construction by Corps Sappers on the Laroche road just outside Marche, further on the routes would have to be swept for the inevitable mines.

On the day of the arrival of No. 2 Troop in Marche, the 1st Canadian Para. Battalion and the 9th Battalion advanced eastward, the Canadians to Roy and the 9th to Bande. Both these villages were extremely isolated at the time and it was imperative that routes be opened up to them as soon as possible. No. 2 Troop at once set to work sweeping three miles of woodland track from the bridge site to Roy. This task continued through the night, with sections relieving one another on the detectors. Tom Marsh and Teddy Knox between them, found three "R" mines. Since these were brand new specimens of a very recently produced mine, I thought they would make good demonstration models, and so later that night I took them back to our billet in the town to thaw them out before neutralizing them.

By midnight we were through to the Canadians, and to prove it I took a jeep over the newly completed bridge and through the forest to Roy. It was an eerie business approaching the village through the silence of the snow, expecting to hear the quiet determined challenge of a sentry at any moment. When this did occur we were directed to the nearest company H.Q., which was not at all easy to find since all buildings seemed alike in that

ghostly white village. Blundering into the wrong room a few minutes later, I caused a loose door to fall on to the head of a sleeping Canadian. Anyone less tough would have probably received a cracked skull, but he waved away my profuse apologies and showed me the correct way to Company H.Q. After exchanging news and views with the company commander and drinking some mess-tin tea, we returned to Marche.

To avoid any accidents with the mines we had collected from the woodland track, I rose early next morning and neutralized them, the task was quite simple now that they were thawed out. The O.C. arrived during the morning and gave me a good "telling off" for so doing. Apparently an order had come through the day before saying that no mines would be dealt with in this way because of the large number of accidents which had occurred recently. In future we had to destroy as many mines as possible *in situ*.

The 11th was spent in the clearance of further roads out of Marche, with the assistance of two sections of No. 3 Troop. At one road junction, well along the road to Laroche, we swept some "Tellers" from the small mine-belt which had wrecked a "half track" vehicle belonging to the Gunners of the 53rd Division. Here No. 1 Troop passed us and built a small 30-ft. Bailey bridge a short distance up the road. They quickly finished it and returned to their billets at Lessive, rejoining the squadron on the 12th.

Mines

These were encountered in large quantities all along the front, and during the ensuing week there were a number of casualties amongst the divisional engineers. Apart from the many types laid by the enemy, we were faced with belts of American mines, which had formed part of their hastily prepared defences during the grim days before Christmas. All mines encountered were buried in snow and, since they were iced up, were both difficult and dangerous to handle. Every route had to be swept carefully before vehicles could pass along it; on all sides appeared the signs with which we had become so familiar in Normandy. The red triangles and the forbidding "Danger Mines," also the more cheerful "Road and Verges Clear," or the sign "Road Cleared to Verges," which warned one to keep away from that tempting space at the roadside.

It paid to have a healthy respect for verges, since one never knew when a mine had been overlooked even after the verge had been swept. Sometimes fresh snow would cover a small dump of mines and the place would become as deadly as before. Backing his jeep on the hill outside Marche, Bob Merrell of 591 Squadron went 2 ft. on to the verge and then about 10 ft. into the air off an American "M.I." The jeep was written off and he went to hospital with an uncomfortable wound in his rear.

As in North Africa and Italy, all vehicles had their floors sandbagged so that casualties were minimized. A good example of the uncertainty of the situation at times was related to me by the irrepressible Jock Hinshelwood of 591 Squadron, after the opening of the main road Marche–Rochefort. Along this route, Jock's troop had cleared one belt which had taken a healthy toll of both the enemy's vehicles and our own. Soon after reporting the obstacle "Clear," Jock was horrified to learn that two more vehicles had "gone up." After closer investigation, the area was found to be liberally sprinkled with the latest German effort made up of glass and plastics which did not respond to our detectors.

A nasty accident occurred in 591 Squadron when a man attempted to unscrew the top of a "Teller." Unfortunately the mine was armed with the latest anti-unscrewing device, which caused it to explode.

BANDE—THE MASSACRE AND "BANDY" BRIDGE

The only Germans we, in No. 2 Troop, saw this week were three forlorn prisoners, travelling to the rear in the cold comfort of a jeep trailer. Despite the lack of personal enemy supervision, we had a most unpleasant time. The 9th Battalion had occupied the village of Bande, some ten miles south-east of Marche, on the 10th. Here they found the village largely burned and in the cellar of one gaunt skeleton of a house, they discovered the snow-covered bodies of thirty-four male civilians. On the 12th, No. 2 Troop were ordered to build an improvised bridge on the site of the demolished one in the same village. The bridge would open up a much better supply route for the battalion than the one in use at the moment. The bodies of the victims of the atrocity were laid out in a small hall quite near the bridge. For two days we witnessed pitiful scenes as the bereaved relatives arrived to view them. Whilst working at the bridge, I was approached by a local who told me the story of the massacre. As near as my halting French could follow, it happened this way :—

Bande had a bad name amongst the Germans for its resistance activities—six months previously, the larger part of it had been burned in reprisals. The joy of the inhabitants on the arrival of the Americans in October was equalled in intensity only by their sorrow at the return of the S.S. Panzers at Christmas. These brave Belgians again took the war into their own hands and Germans began to die in the snow. Reprisals were swift, and forty men were arrested and held as hostages in the village. On Christmas Eve, at dead of night, they were taken out one by one and told to enter a ruin nearby. As each came through the door he was shot through the back of the head and his body fell into the cellar below. Two Gestapo executioners had been specially imported for the job. The luckless captives soon realized what was afoot, and after the fifth shot, the man to whom I was talking, for he was in that room, had urged the rest to attempt a mass break-out rather than be slaughtered one by one. The wretches were too terrified of the rifles of the guards to take any concerted action. My informant therefore decided to make a break himself. When the sentry next opened the door and hauled out a trembling prisoner, he knocked him down and fled away through the ruins. Five others made good their escape before the guards regained control. The remainder died like cattle in that cold shell of a building.

No. 2 Troop commenced bridging at Bande, early on the 13th January, and the bridge was finished on the night of the 14th. It was an odd-looking affair which proceeded at an angle from one bank to what was left of the old pier in midstream and then over part of the original structure to the far bank. Because of the "dog-legged" effect it was given the name "Bandy" Bridge. The final touches were put to it on the 15th, when the name and classification were put up on a tree nearby.

THE PASSING OF TEDDY KNOX

Before leaving for Bande on the 13th, I had to detail a small party to assist infantry pioneers in mine clearing. I asked Teddy Knox to carry on with this whilst Tom Marsh and I went off to finish the bridge as quickly as we could. Returning that evening, we found that Teddy was still out so I went up to Brigade H.Q. to find out what he was doing. The Brigade Major told me that Teddy had been killed whilst mine lifting during the afternoon ; he took me to the Brigade Commander who related the facts. Teddy had gone with some pioneers to Marche station where a belt of American mines seriously obstructed the main road. To avoid damaging the houses all around,

Teddy had been lifting the mines to take them away for destruction. He was doing all the actual lifting himself and was using an iron bar to prise the mines from the snow. He must have depressed the "spider" cover of the last one he attempted to lift as it exploded and he was fatally injured. An ambulance was passing at the time so he received medical attention as quickly as possible, but it was too late and he died before reaching the C.C.S. in Marche.

Very sick at heart I returned to the troop location to break the news to Tom, Sergeant Docherty and the rest of them. An original member of the troop, Teddy dropped with us in Normandy, only to be wounded immediately—before he could get out of his harness. We next saw him in England when he rejoined us, now after only three weeks he was taken away for all time. A big fellow and always cheerful, his depth of character and good nature had allowed us to make him the butt of our humour at times. His solidity had been a pillar against which many of us had rested.

Nights in Marche

Whilst in Marche, we were visited nightly by some old friends of the Ecarde quarry days—the J.U.88s. Anti-personnel bombs were dropped and on one occasion they caused several casualties amongst troops in the town. The same night, a stick of them fell across 3rd Brigade H.Q., and in the morning we were called upon to deal with an U.X.B. there. As I was setting off to look at it, the O.C. turned up and decided to come with me. We met Bobby Gordon, the Brigade Major, an old friend of Rosie's, who led us through the buildings to a roped-off section of farmyard. In the centre of it a suspicious metallic cylinder protruded from its bed of snow. Stepping past the rope, Rosie and I could not restrain our mirth since the U.X.B. was nothing but an old grease gun. We certainly had the laugh on brigade that time.

Corporal Cross

One who did a great deal to ease the workings of the unit through all its operations, was our Troop Q.M., Corporal A. H. Cross, a very hard-working and extremely competent Scot. An accomplished violinist, he was the mainstay of the engineer dance orchestra in our days at Bulford. He never spared himself to help the troops, who quite often had, of necessity, to live under less favourable conditions than those in Squadron H.Q. When troops were too distant from the Squadron to allow frequent visits, he would come out weekly to bring N.A.A.F.I. rations, mail and any comforts he had been able to obtain. I am glad to record that he received the award of M.B.E. in 1946, by which time he was S.Q.M.S. of 3rd Airborne Squadron serving in Java.

Final Work in Marche

On the morning of the 14th January, at the wish of Brigadier Hill, I went into the minefield at Marche station searching for booby traps. Although I was convinced that there were none there, it was possible that Teddy Knox had been killed by unwittingly initiating one. I lifted several mines, discovering that it was not possible to neutralize some of them before lifting because they were iced up ; this was one of the reasons for Teddy having an accident. A lady from a house nearby asked me for details of his name, since it was her intention to place a plate on the house wall near the spot. I hope to visit it some day to find out if her intention was carried out.

The mines in the region of Marche station remained a great danger to vehicles and passers-by and there was another fatal accident on the 15th.

This time it was Lieutenant Gordon Wade of 591 Squadron who lost his life in a very similar manner to that of Teddy Knox, whose funeral we attended the same afternoon in the churchyard of the village of Jamodin. On the 16th, Tom Marsh took a section over, and blew up the most exposed ones, nearly wrecking a terrace of houses in the process. We did not dare go near the spot after this.

On the 15th, No. 2 Troop moved to the billets of No. 1 Troop in Lessive. A scheme was afoot whereby all troops would begin the construction of heavier Bailey bridges in the area of Rochefort. Higher plans interfered, however, and the Squadron concentrated in the village of Wanlin in the new 3rd Brigade area some miles west. Rumours began to fly around concerning moves to all parts of B.L.A. and U.K., but we thankfully settled down in Wanlin and attempted to forget the events of the past few days. We began to prepare for training the infantry battalions in mine work, but this again fell through upon receipt of further news on the 19th.

JANUARY 19TH–23RD

Holding a long stretch of the Maas in Holland, was the 15th Scottish Division, which had been in the front line almost without a break since D-day. On the 19th we learned that our division was going north to take over this sector and allow the 15th Scottish to have a rest.

We did not leave our small village until midnight on the 21st January. The inhabitants made us as comfortable as possible until then, and, as in Vichte, we found everyone most hospitable. For the first time in the field, the Squadron was able to open an officers mess in Wanlin. Across the road from this mess, Tom Marsh and I were billeted on the village schoolmaster who was overjoyed at our acceptance of his hospitality. He regaled us with tales of the occupation and we were astonished at the patience and forbearance of these simple villagers. This village had been the centre of the local resistance movement, and a large cache of arms had been made in an empty tomb in the graveyard.

In order to arrive at our destinations in Holland in daylight, we had to leave our locations in the Ardennes during the previous night. We joined the 3rd Brigade column on the night of the 21st and followed it right up through the Ardennes and eastern Holland to our new location in the village of Heijthuijsen, five miles west of Roermond. We arrived late in the afternoon of the 22nd, after a journey as cold as any we ever experienced. Frequent halts were necessary to allow drivers to restore their circulation before changing over. Our jeeps were not built in at this time and the only way for a passenger to exist was wrapped in blankets or sitting in a sleeping bag. Fifteen hours in this convoy was enough to tax the endurance of the toughest.

REFLECTIONS ON THE ARDENNES

We left the Ardennes with the feeling that we had done something towards helping the Yanks out of a tough spot. Our contribution had been small enough, but the mere fact that we had been "on the ground" had enabled the American formations engaged to carry out some much-needed re-grouping, preparatory to ironing out the bulge in their front. Experience of the conditions of this sector had caused us to appreciate even more fully the tough and heroic resistance the U.S. forces had put up long before our arrival. We left the sector feeling full of admiration for the G.I., in particular for those in the 101st Airborne Division.

The Ardennes Offensive

It would be appropriate here to make a few remarks on the Ardennes Offensive as a whole.

On 16th December, under cover of weather unsuitable for flying, the enemy launched a large-scale attack on the thinly held American sector of the Ardennes in eastern Belgium. The attack was an armoured one, involving a Panzer force of some twenty divisions. The whole was under the direct command of Von Runstedt, who was, in the words of Field-Marshal Montgomery, " a far better commander than Rommel had ever been."

The offensive was extremely well timed and placed. The allies were still feeling the effects of the grand " Swan " across France, Belgium and Holland. The allied "spring," though still very powerful, was stretched nearly to the limit and was engaged in recoiling itself for the next blow. Everywhere lines of communication were being shortened by the move forward of the vast dumps from the Normandy bridgehead. The Canadian army had just conducted its gruelling offensive in the Scheldt estuary and the clearing of Antwerp. This great port would not be ready for use for some time, and was being subjected to a continuous barrage of flying bombs. As yet, the allies had no other port capable of supplying the forward areas with a large and steady flow of men and material.

A victorious army attacking through the Ardennes, reaching and crossing the Meuse at Namur and Dinant, would have the road to Brussels and Antwerp open before it. Again, the rugged hill country of this region was seemingly one of the last places one would select for an armoured offensive.

Von Runstedt probably intended to cause sufficient disruption of the allied plan to necessitate the indefinite postponement of the assault on Germany. A successful offensive might allow the opening of abortive peace negotiations, whilst new and more horrible secret weapons were being perfected.

The offensive was launched on a fifty-mile front on the sector held by the U.S. Eighth Corps. Its initial success was striking but General Eisenhower reacted instantly. The shoulders of the " Bulge " were reinforced by the U.S. First Army from the north and the U.S. Third Army from the south.

Such was the initial success of the German thrust, that it cut right through the lines of communication of the U.S. Twelfth Army Group, commanded by General Bradley, with the result that he was no longer in a position to control his two northern armies, the First and Ninth. Accordingly, on the 19th, Field-Marshal Montgomery was requested to assume command of these formations and all troops north of the bulge. The 21st Army Group was, at this time, in the process of concentrating in the north in preparation for the clearing of the Rhineland, but on his own responsibility " Monty " had already ordered 30th Corps to cease concentrating in the north and to move at all speed into positions to the south which would cover any German dash across the Meuse in the direction of Brussels. The 29th (Br.) Armoured Brigade was pushed across the river to cover the approaches to Namur and Dinant, the first British troops to contact the enemy in this offensive. This brigade fought engagements in the Ciney area on the 24th and 25th, inflicting great damage to enemy spearheads, which penetrated to within four miles of Dinant. At the same time, the 6th Airborne Division arrived on the scene and was pushed across the river to make contact with the enemy in the area of Celle. The 30th Corps now took over the sector Hotton–Givet on the right flank of U.S. First Army.

At the time of writing (Spring, 1947), it is interesting to read of the breach in allied relations which almost reached serious proportions at that time.

The worst commentary has been made by Ralph Ingersol in his book *Top Secret*. He castigates Montgomery and the British Press for attempting to steal the glory rightly earned by the U.S. forces engaged. He makes the incredible statement that only one British Brigade was engaged in the fighting, presumably referring to the actions of 29th Armoured Brigade which fought alongside the 2nd (U.S.) Armoured Division in the Ciney-Celle area. If he had been present at the carnage in which the 5th Para. Brigade was involved at Bure, he would most probably have thought again before making such a statement.

Reading Montgomery's *Normandy to the Baltic*, De Guingand's *Operation Victory* and Alan Moorehead's *Eclipse*, one sees an amazing contrast in generosity. Each of these outstanding personalities of the British side at that time, lays great stress on the remarkable feat of arms and the heroism of the American soldier in the Ardennes. But for the manner in which individual U.S. units fought to the bitter end after they had been surrounded, the delayed break-through by the German tanks would have been a headlong rush up to, and even over the Meuse, with little to stop it. No claims are made for the British formations engaged, except that they played first a holding rôle to cover the vital approaches to Brussels. They then pushed back the tip of the bulge as far as Laroche and St. Hubert, while the bulk of the fighting was done by the U.S. forces, which cut their way into the salient from each flank.

We of the 6th Airborne Division can bear further witness of the stubborn resistance put up by the Yanks before we ever arrived in the Ardennes. All the way from Celle to Rochefort one could see a welter of knocked-out German tanks and heavy equipment, partly accomplished by the allied fighter aircraft when the weather lifted between 23rd and 26th December, but in the main the results of magnificent fighting by U.S. troops against vastly superior forces. When we were in the Ardennes, our old friends the U.S. 101st Airborne Division, were stubbornly holding out in the surrounded town of Bastogne, besieged by fearful odds.

The credit for smashing the onslaught of the three German armies involved —Fifth Panzer, Sixth Panzer and the Seventh Army—goes to the U.S. forces engaged and to the R.A.F. and U.S.A.A.F. tactical forces which "went to town" on the massed German columns when the fog lifted on the 24th. The 30th Corps, comprising 6th Airborne, Guards Armoured, 43rd, 51st (Highland) and 53rd Divisions, with three independent Armoured Brigades, was never committed to an all-out offensive on a very large scale. It is true that the British were comparatively fresh, whilst the U.S. forces which Montgomery put back into the attack, had borne the brunt of the German attack, but there were good reasons for not exhausting 30th Corps. These Divisions had soon to help clear the Rhineland and also to carry the invasion into the heart of Germany, there were no fresh formations arriving, as was the case with the Americans. Further to this, the employment of large forces of British troops anywhere except at the tip of the salient, would have meant upsetting the lines of communication of the U.S. armies engaged. As we saw to our cost when we were moving up from eastern Belgium at Christmas, the supply routes west of the Meuse were already badly congested. Again a strong force had to guard the approaches to Brussels in the event of a complete German break-through, as seemed extremely likely during the initial phase of the battle.

Having played a holding rôle, 30th Corps then pushed back the tip of the salient. The heaviest fighting took place on the flanks of the salient. Enemy forces at the tip had to depend on three routes of supply, the northerly one,

St. Vith–Rochefort, soon came under fire of the guns of U.S. First Army. The centre one, St. Vith–Houffalize, soon became choked with transport, because the southern route, through Bastogne, was obstructed by the U.S. forces holding out in that town. The result of all this was that by the time 30th Corps and 6th Airborne Division arrived, the sting had gone out of the German attack. The panzer spearhead had lost its momentum, whilst the forces behind it were fighting hard to widen the salient in order to avoid the inevitable strangulation of its tip.

Holland, 23rd January–19th February

The divisional sector now lay along some twenty-five miles of the river Maas between Maaseyck and Venlo. Owing to the flatness of the terrain, the broad river obstacle and the "thinness on the ground" of both ourselves and the enemy across the river, the front was generally very quiet.

War on this front was reminiscent of the "phoney war" on the western front during the winter of 1939–40. Before us stretched a broad expanse of flat "No Mans Land" split in two by the wide and swiftly flowing Maas. The most the division was expected to do was to maintain vigorous patrol activity; this it did.

Within a mile of the river bank, the only habitations were isolated farms and a few small hamlets. Consequently the infantry were spread out in a series of strong points, many of which, owing to their visibility to the enemy, could only be approached at night. Each side had its O.Ps. set back in the villages, perhaps so far as two or three miles from the river bank. The enemy O.P. commanding the area occupied by 3rd Brigade was in the high church tower of Roermond itself. Since there seemed to be a certain amount of "live and let live" regarding O.Ps. at this time, our guns left it alone. I am glad to say that we had a preponderence of artillery over the Germans in this sector, a medium regiment and a number of S.P. guns were in the vicinity of Heijthuijsen. When the odd enemy S.P. gun trundled down to the river after dark to have a little hate, the "muck" was returned with some hundred per cent interest.

Although this sector was relatively quiet, the 15th (S) Division were glad enough to get out of it for a real rest. The field company whose billets we took over in the village, had just completed a large dual carriageway Bailey over the Wilhelmina canal, between us and the town of Weert.

Vigorous Patrol Activity

On the 23rd January, the day of taking over the area, a complete engineer reconnaissance of the whole length of the river bank was carried out. The primary object of the reconnaissance was to find suitable crossing places for small boats, which would carry patrols to the enemy bank. Secondly, to take a look at covered approaches, minefields, demolished bridges and other interesting features in the vicinity of the river.

Between 3rd Brigade H.Q., in Heijthuijsen, and the river, was the village of Horn, occupied by the 9th Battalion. Here a broad highway ran straight towards the main crossing of the sector at Roermond. This crossing had been extremely well converted into a multiple obstacle by the Germans during their withdrawal. A mile or so downstream of the obstacle was a large demolished railway bridge, which lay just inside the area of the 1st Canadian Para. Battalion. Upstream of the obstacle was a great expanse of low-lying swampy ground which soon became flooded during the ensuing thaw. The 8th Battalion were holding a strip of the bank downstream of the Canadians, beyond them were the 5th Brigade, and 6th Airlanding Brigade were further north still.

We sent out small patrols as recce parties with the battalions, to look at the bank in the respective battalion areas. That night I reported to 9th Battalion H.Q. in Horn, with two Sappers as the engineer members of the patrol. Lieut.-Colonel Crookenden, the C.O., had decided to lead the patrol and we set off, together with three of his men. Our route lay through the outlying hamlet of Heel and the patrol was accompanied so far by a platoon going out to relieve the one holding the position there. Half-way to the hamlet we crossed a small creek, which our predecessors had bridged with a small Bailey. The bridge had been lifted right up by the floods and had settled back in a very unstable condition. As the party scrambled over, the loose chesses of the bridge gave vent to a great clattering. This noise was apparently well known to the enemy who would listen for it every night and after hearing it, would allow just sufficient time for the relief to arrive at the platoon position before "stonking" it liberally with a conveniently placed mortar. On this occasion they timed things nicely, so that we arrived in the village to the accompaniment of several "stonks," which showed that the enemy was well awake. While the bombs were landing in the village, Colonel Crookenden was standing up in the open, taking compass bearings on the distant sound of the mortar barrel. I was glad I did not have a compass with me. Later that night I saw the position of this mortar accurately plotted from his readings and from some obtained previously. The gunners were allowed to have a go at it on the following day.

From this forward position we went cautiously forward to the river bank. Here we proceeded to move along slowly, looking for the best position for launching small boats. By this time the moon was well up and visibility very good—we could see a long way across the flat ground on the enemy bank. The banks of the river were very high and there was also a flood bank set well back on each side. Our route lay behind the flood bank on our side. At a very exposed point the C.O. said "Come on, let's see if we can draw their fire." Before he had finished speaking he was strolling casually along the top of the bank, clearly visible for hundreds of yards across the snow in the brilliant moonlight. I followed as nonchalantly as I was able—not feeling very happy. The Germans, if any, must have been looking elsewhere, since no fire came our way. This incident typifies the spirit and fearlessness of our battalion commanders.

The Boating School At Obbicht

It was the intention of the G.O.C. that each battalion would carry out offensive patrols on the far side of the river. To this end, men had to be trained in the handling of small craft on the wide and swiftly flowing flood. Accordingly, the C.R.E. asked 3rd Squadron to set up a School of Watermanship. The school was started at the village of Obbicht on the east bank of the Maas, some thirty miles up-river from us, between Maaseyk and Maastricht. It was run at first by Jack Nash and half of No. 1 Troop. They put a number of infantry candidates through courses, and later had the honour of putting the first recce party, from the 8th Battalion, across the river on the night of 28th January.

Whilst No. 1 Troop were thus engaged, the rest of us had been given an extensive task of sandbagging defence positions for the forward platoons, work which was complicated by the fact that some positions were unapproachable by day. The task of road maintenance again reared its ugly head, also our mine clearance drills and technique were revised and our accessories for this work overhauled and brought up to date.

Tom Marsh accomplished another fine recce on the 28th. He made a very thorough examination of the obstacles which the enemy had effected

at the Roermond crossing, and produced an excellent report. It was a long and difficult task, carried out in the area most closely watched by the enemy, at the dead of night in the "Deathly 'ush" which existed along the river.

About this time, the big thaw set in. For days everything streamed with water, the waterlogged roads went to pieces under the stream of traffic, they bulged and crumbled in all sorts of places. Parts of the side roads were turned into deep morasses and from this time, whenever a section had no other specific task, it was sent out on road repair.

Hospitality in Heijthuijsen

It did not take us long to get our "feet under the table" with a vengeance in this little Dutch village. The Burgomaster provided billets for all ranks and made us very comfortable. A mess was established for the officers in the house which offered its hospitality to the O.C. Called the "Sun House," it was a very beautiful place and we had some very happy evenings there. Tom Marsh, Frankie and I, were particularly fortunate in being allotted to the house of Mr. Hendriks, bailiff of large estates in the district. He and his family spared no effort to make us comfortable and would have allowed us to eat all their rations if we had so wished.

Hendriks' house was quite full before we arrived and we were fitted in only because the family were still sleeping downstairs although there was little fear of anything beyond the odd shell coming their way. In addition to the old man and two sons, two of his daughters and the fiancé of one of them were also living there. A third son was a slave worker in Germany, having been forcibly abducted from the church after morning service one Sunday. Harry, the girl's fiancé, had narrowly escaped capture himself on that occasion. The Germans were seizing all men as they came out of the church—Harry came out dressed in his fiancée's clothes and escaped. The girls were attractive, one blonde and the other brunette. During the occupation they had shown great spirit and had been known amongst the enemy as "the Blonde and the Black Cat."

Obbicht

The School of Watermanship assumed quite large proportions. A liberal array of small craft was obtained for it by the field park company and for a time the river bank at Obbicht resembled the "hard" at any bridging camp in England, with Jack Nash as chief instructor. Then came the floods, and the river doubled its size at many points. Two large and very fine Bailey pontoon bridges erected by Corps and Army Sappers along this sector, were very nearly washed away, and at times were submerged and impassable. At such times the only route to the boating school lay via Maastricht some distance upriver, well inside the American zone. At Maaseyk, American engineers were building a timber pile bridge alongside the Bailey. They lost a large floating pile driver when the flood came upon them.

The rapidly expanding river was a constant source of apprehension at the boating school, since much of the equipment was in danger of being carried away and had to be watched carefully. Work had to stop for some time, since it was impossible to put trainees on water which was extremely dangerous even for experienced watermen. At this stage the school was taken over by No. 2 Troop, and Tom Marsh became chief instructor. Across this sector of the river frequently passed the flying bombs on their way to Brussels and Liège; one could sometimes see half a dozen in as many minutes. Owing to the state of the river there was little to occupy personnel at Obbicht. One could watch the "buzz bombs," go out to see if the river was navigable, play poker, or write home, it was a rather trying existence for a week or two.

Fun and Games Round the River

No. 3 Troop had carried out the recce of the large demolished railway bridge in the Canadians' area, and found that it was still possible to get across the wreckage by doing a sort of "Tarzan" act. To aid the passage across of infantry patrols, they converted the bridge into an aerial roadway festooned with hundreds of feet of climbing ropes and rope ladders.

Vigorous patrol activity continued on both sides and we did not always come off best. On two occasions to my knowledge, the enemy carried out surprise attacks on our outposts. The first of these was done in comparative strength, small parties being ferried across and hidden in woods for two nights until sufficient strength for the attack had been built up. The enemy succeeded in getting away with a couple of prisoners on that occasion.

The second attack was carried out stealthily against a lonely farm in the area of "C" Company, 9th Battalion. The farm must have been under close observation, since the attackers came silently in, using the same route and method of approach as that adopted by the relief which came every second night. No harm was done by this surprise, but it added to the strain under which the forward troops had to live. Following this attack, No. 2 Troop were ordered to visit the farm and to blow down any buildings which the defenders considered to be obstructing the view. I went with Sergeant Docherty and some Sappers, we took turns in carrying a large box of explosive. The position was so far forward that it took an hour for us to walk to it after leaving battalion H.Q. in Horn. The route lay straight down the main road to within 300 yds. of the blown bridge before it struck upstream across the flooded fields and fenland. Before reaching the spot at which one left the road, an enormous crater had to be crossed, this was the first part of the multiple obstacle at Roermond. Upon inspection of the work required at the farm, I decided that it would be much less noisy and equally effective if the work of demolition was done with felling axes, this would also save the explosive. The idea had been that we were to prepare a demolition and then ask the guns to fire a few rounds for us at the time we wished to touch it off, in order to conceal the fact that we had done anything at the farm.

On the night of 14th February, Lieutenant Franklin took out a small party of No. 1 Troop and cleared a safe lane along some 1,100 yds. of the flood bank near the tiny hamlet of Heel in the 9th Battalion area. This task necessitated crawling the whole length required to be cleared, prodding for mines en route. Twelve "Schu" mines were picked up on this occasion.

More Mines

The battalions still wanted some more training in mines. Accordingly No. 1 and 3 Troops set up cadre courses for the 8th and 1st Canadian Battalions. Some live mines were assembled for this task and their presence in a billet of No. 3 Troop led to a very nasty accident. In this accident we suffered the loss of Sergeant Shrubsole, M.M., Corporal Banbury, Sappers Boyle and Aylard. By a whim of fate these chaps had all assembled in this billet during the daytime in order to hold a Court of Inquiry on another accident which had occurred a week or two previously. In this accident Driver Atkins had lost his leg as the result of the explosion of a "Panzer Fist."

The tragedy of all the deaths which occurred in the divisional engineers in Belgium and Holland as the result of mine explosions, was that they were all due to avoidable accidents. It was a lesson well learned, however, and no further accidents occurred.

Last Few Days in Holland and Belgium

It was clear from the good progress being made by 21st Army Group in the clearing of the lower Rhine, that we were fast becoming a backwater. It was also very clear to us that we were not the type of formation which would sit out the war having a good time in this part of Holland. Rumour was rife during the second week of February, when we were passing the time doing sporadic road maintenance. Then suddenly we had it "in writing" that we were going home to prepare for another airborne operation. The Americans to our south came up to take over the sector. It was clear that the locals did not care for them at first, but I am sure they soon came to like them and to look after them as well as they had us.

The army always seems to start its worst moves in the middle of the night—an obvious security precaution, but one which is not conducive to the keeping of tempers. At 2230 hrs. on the 19th February we left Heijthuijsen by road convoy after tearful farewells from the kind folk to whom we were saying good-bye. We arrived at our destination in western Belgium at 1130 hrs. on the 20th, after quite a pleasant run across Belgium in the early morning.

Our new location was a lovely château at the village of Biervelde, near the city of Ghent. Old friends were to be seen in the city and in the officers' and O.Rs.' clubs. We could buy champagne at 65 francs the magnum. I heard it said that during the reoccupation of the city, the allies had discovered a German dump of a million bottles, and this was now being drunk in the hospitals and Service Clubs. We envied the lucky ones who landed themselves jobs in such areas. On the 23rd we moved by train to Ostend, where the whole unit was housed in the extremely well-run transit camp.

Only the Para. Squadrons returned to England on this move. 286 Field Park Company remained in their location in Holland, to join us later on with the "Build-up." 249 Field Company had not been with us in Holland; we saw them near Ghent, very "browned off" with being out of the picture for so long. They also were to stay in Belgium and join us later.

After a further two days in Ostend, whilst we waited for shipping to take us across the channel, we moved suddenly one night to Nivells airfield, near Waterloo in the Brussels area, to be flown home. It was high time we left Ostend anyway, since we were nearly all "broke" by this time. The city sported a very fine officers' club run by N.A.A.F.I., drinks were very cheap and of the very best.

At Nivelles, the procedure was efficiency itself, and once again we took our hats off to R.A.F. Transport Command. We climbed stiffly out of our lorries, were given liberal refreshments, allotted to aircraft and found ourselves above the clouds in Dakotas, all within three-quarters of an hour.

The aircraft took off and flew independently to Broadwell aerodrome near Swindon. It was a glorious and exhilarating trip. We remained in brilliant sunshine, above a snow-white carpet of cloud, all the way. Morale was never higher, no one gave much thought to the return journey, which was to be made a few weeks later. The fact that single unarmed Dakotas could fly to England, was a tribute to the R.A.F. mastery of the air, no sign was seen of the Luftwaffe.

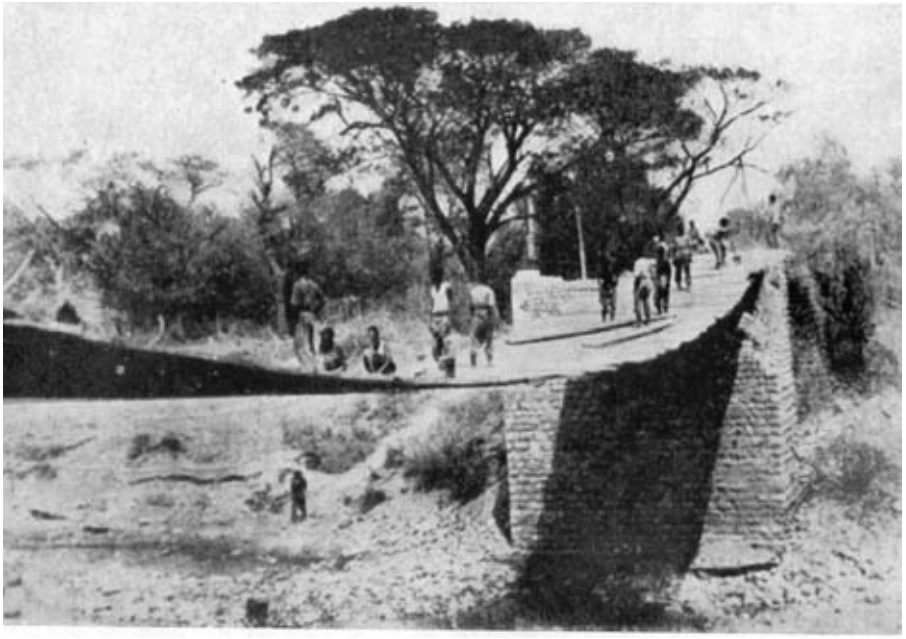
At Broadwell things again went like clockwork; we were delighted at being met by smiling W.A.A.Fs., who drove us to the side of the 'drome in their trucks. There, after further refreshments, we climbed once more into the backs of "3-tonners" and moved off to Bulford.

(To be continued).

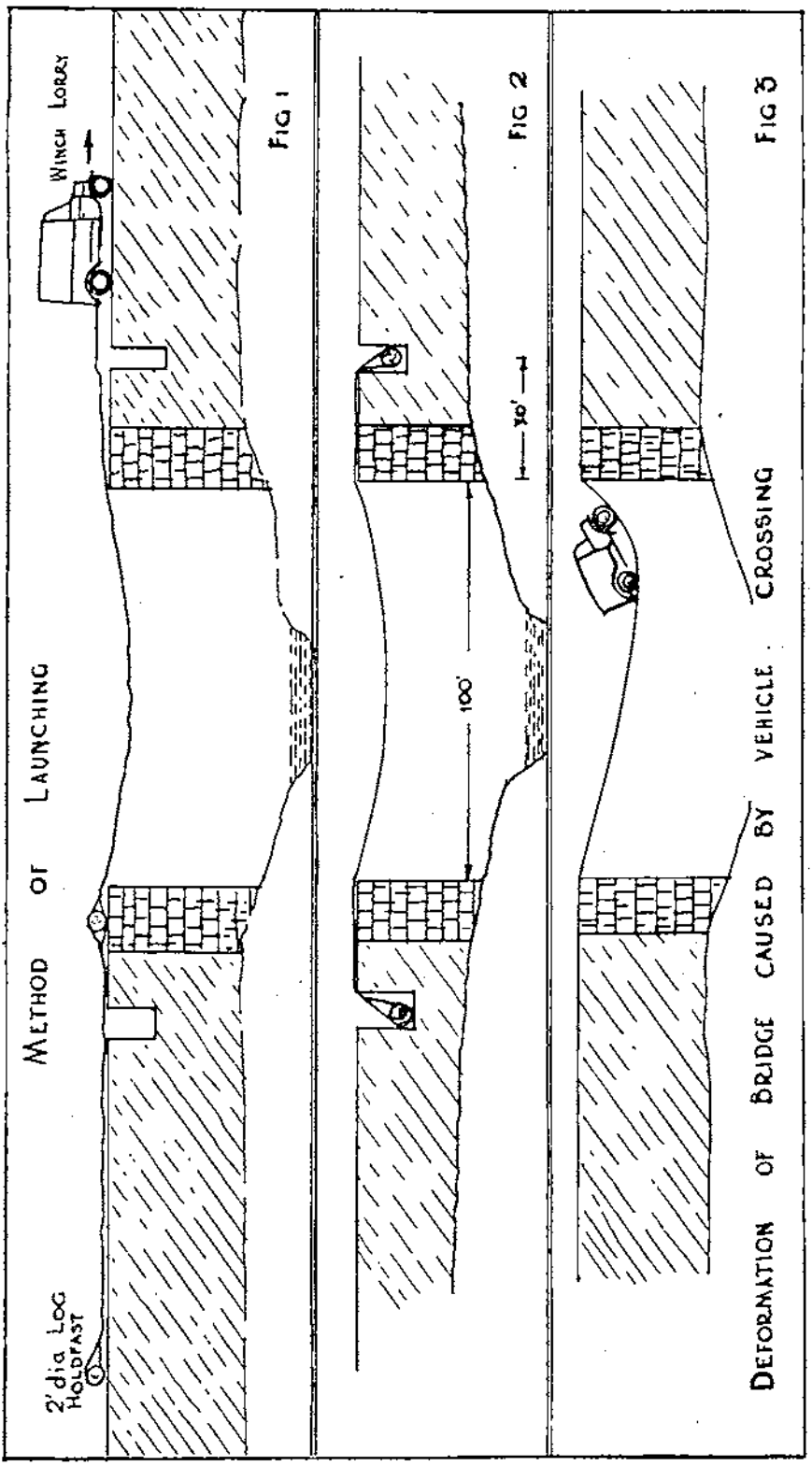
Photo 12.—The Ardennes, January, 1945.

Photo 13.—The Ardennes—mines in the verge.

Go to it 12,13



Ywata Bridge


METHOD OF LAUNCHING
WINCH LORRY
2' dia LOG HOLDFAST
FIG 1
100'
30'
FIG 2
DEFORMATION OF BRIDGE CAUSED BY VEHICLE
CROSSING
FIG 3

METHOD OF SECURING DECKING

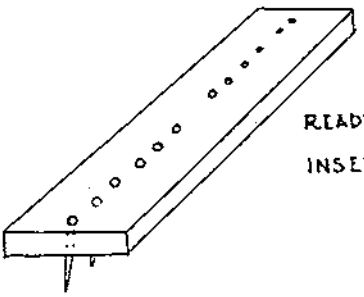
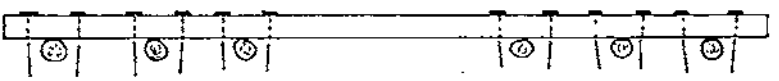
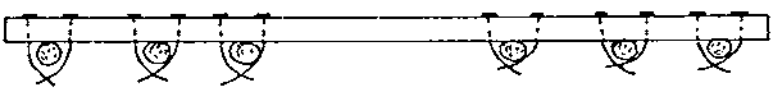


FIG 4.



DECKING PLACED ON CABLES AND READY FOR SECURING

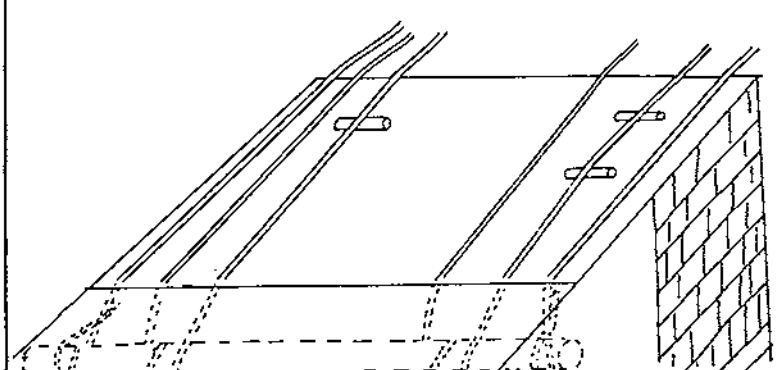


6" NAILS BENT WITH HAMMER TO GRASP CABLES

METHOD OF TENSIONING CABLES

FIG 5

SHORT TIMBERS WEDGED BENEATH SLACK CABLES ALL CABLES THEN COVERED WITH MACADAM RAMP



out the total permissible load, as it was beyond the scope of the *R.E. Pocket Book*, and limited recollections of formulae gleaned from nine months at Cambridge.

As far as can be remembered, the calculations and chain of thought ran roughly as follows :—

(*a*) Two 3 in. S.W.R. cables required for a true suspension bridge for Class 9 traffic to cross a 100 ft. gap, i.e., with cables hung in true catenary with maximum dip (from *R.E.P.B.*).

(*b*) Dip would have to be a minimum if decking was to be placed directly on to cables, otherwise vehicles would never make the grade.

(*c*) Dip must not be too small, otherwise abutments would pull in (an incalculable factor).

(*d*) Four 3 in. S.W.R. cables required for a minimum dip of 6 ft. (*R.E.P.B.*).

(*e*) Maximum number of cables would have to be used in order that the decking might not fail, as there were no road bearers or transoms.

(*f*) Six cables could be made from the one available drum.

From this it was reckoned that the bridge could be termed reasonably safe if six cables were used. There must obviously be a way of determining all this accurately, but *R.E.P.B.*, apart from stating bald and very limited facts, could give us no further advice. I remembered at the time having been told in the dim and distant past, that when in trouble with cables, resort to first principles and differentiate, but my efforts, on the back of the proverbial envelope, to " take a little bit of cable " were handicapped by having forgotten the general formula for a parabola.

The C.R.E. arrived on the site shortly afterwards and wanted to know exactly what was happening. I could do nothing but assure him that I had a hunch that it would work, and on such flimsy evidence, I was rather surprised when he gave me permission to carry on. He probably felt justified by the sight of the stream of traffic pouring over the F.B.E. bridge.

The rest of that day was spent in reeving the cable round the two log holdfasts, and hours were spent trying to equalize all six returns.

On the third day, a 3-ton winch lorry was sent over the F.B.E. on to the far abutment, and proceeded to winch the far holdfast complete with cables across the gap. As soon as the near holdfast was dragged to its trench, it was bedded down firmly. The far holdfast had by this time just reached the far abutment, where it refused to go any further owing to the strain on the cables, and a further winch lorry had to be harnessed on to the first before the log could be persuaded into its trench.

In spite of the preliminary adjustments, each cable was found to have a different amount of sag, and this was eventually cured by inserting timber baulks between the cables and the abutment top, rather after the fashion of the " bridge " of a violin. All the cables on the approaches were then covered over with macadam ramps.

The cables had been reeved in two groups of three, to coincide roughly with the wheelbase of the average 3-ton vehicle. The decking was then pre-bored as shown in Fig. 4 to coincide with the individual cables. The decking was secured by means of 6-in. nails inserted in the holes and bent round the cables with a hammer. Decking parties worked from both ends of the bridge and each consisted of four carrying members and two armed with hammers.

As a final precaution against individual decking pieces coming adrift,

½ in. S.W.R. rafting cable was stapled diagonally across the top of the decking. This had the added quality of providing a non-slip surface for both vehicles and pack animals. Timber ribands, 4 in. by 4 in. and hessian anti-fright screens hung on S.W.R. rafting cable were finally fixed to complete the job.

The first vehicle, a fully loaded six-wheeled Dodge, crossed the bridge on the sixth day, and thereafter all Class 9 traffic was diverted over it, the F.B.E. bridge being used as a standby.

Although safe, it was not a comfortable bridge, and oscillated violently in all directions under load. This was curtailed to a certain extent by sway braces attached to ordnance holdfasts on the banks of the chaung, but no cure could be found for the longitudinal distortions of the bridge when the load was not central. It was quite a usual sight to see drivers having to change into bottom gear to get up the far side—a nerve-wracking experience for anybody who had not been over the bridge before.

The recovery of any vehicle that put a wheel over the edge (which happened at least twice) was impossible, and the vehicle had to be pushed completely over the edge to clear the way.

No claims are made for the originality or importance of this bridge—in fact nobody even asked us to build it, but it was great fun.

(Author's note :—The only official comment was passed by C.R.E. 20 Div., who was in one of the first vehicles to cross, and said that he still didn't believe it, as such things only existed in E.-in-Cs. pamphlets.)

WORKS SERVICES

By COLONEL F. C. NOTTINGHAM, D.S.O., O.B.E.

A lecture given to the School of Military Administration on 15th March, 1949

INTRODUCTION

THE subject of this lecture is the Engineer Works Services.

When I was a young officer and had to give a lecture I was told by a more senior one that the best way of putting anything over to an audience was to tell them at the beginning what I was going to tell them, and then to tell them, and at the end to tell them what I had told them. Today, therefore, I am going to tell you something of the present organization of the Works Services and their relations with the staff, how the War Office retains control of expenditure on building in the Army and something of the reasons for the delays in building under present-day conditions.

GENERAL PRINCIPLES

The duty of the Engineer Works Services is to provide the Army with suitable and authorized accommodation, whether in barracks, huts or requisitioned property, and to keep that accommodation in a proper state of repair. They are, in fact, the Army Building Agency.

The Engineer Staff have to work in with the various arms of the services, and the branches of the Staff, and to be ready to advise and help them. It is essential that they should *know* their job, what they can do and what they cannot do.

The Works Services, like other Government Departments, suffer from a lot of criticism for having too much "red tape." The critics are apt to overlook the size of the business of running the Army. In fact, there are few civilian organizations which in any way compare with it, and in those which do, there are regulations. Unfortunately regulations are often applied stupidly. Many which appear unnecessary, are the result of previous stupidities, and it is essential in applying regulations to understand very clearly the purpose behind them. Without that understanding one is working in the dark, as the regulations themselves do not give the reason for their existence, and confine themselves to bald statements of facts, or orders.

For what it is worth, the harassed Engineer officer can gather some comfort in the opening sentences of the Regulations for Engineer Services. These read :—"The Regulations are issued for the guidance of all concerned. They are to be read reasonably and understandingly and with due regard to the public service, bearing in mind that no attempt has been made to provide an answer for self-evident exceptions." The amount of comfort that can be derived from the above is, however, limited, for it does not provide an excuse for the exercise of what is so frequently, and often wrongly, described as common sense ; for these so called "common-sense" methods are so often based on inadequate experience. It is necessary to know the Regulations, as without this knowledge the attempt to break away from them will almost certainly lead to trouble. To give an example :—

A certain Medical Lieut-Colonel Quartermaster rang the D.C.R.E., asking what three large Nissens would cost erected, and how long it would take to complete the service. The Officer Commanding Hospital reported the figure to War Office direct without telling "Q." Approval in principle was given by the War Office and "Q" told to get on with the job. As the service was urgent and within Command powers, the huts were ordered.

What was really required were three fully equipped hospital bedded huts with all the necessary "frills," i.e. bed lights, X-ray power points, special heating and ventilation, drainage etc. This fact was not discovered until the nissen huts were about to be erected. As the funds allotted could not possibly be sufficient for the real requirements, the project had to be re-submitted in the proper way. There was a great deal of argument and delay while the matter was being adjusted, also a waste of vital labour and transport in war-time.

As the project was really necessary it would have been much quicker in the first place to put it up in the way laid down, but the Quartermaster thought it a clever move to take a short cut.

Government Departments are often criticized as being more inefficient compared with civil businesses.

In business, the general manager of a concern is judged on the profit or loss account. If the firm shows a good dividend the general manager is not likely to be subject to too much criticism, even though the accounts may show many bad items which result in a loss, provided that there are sufficient good ones to outweigh those losses. If the account is a bad one, it is in the power of the firm or shareholders to change the management. In a Government Department this procedure cannot be applied. The Engineer officer may carry out ninety-nine efficient projects and show a saving on each, for that he will be considered an efficient and capable Engineer, but he will be unlikely to receive immediate promotion or an award of extra pay. If the hundredth job shows a loss he cannot set off the savings of the ninety-nine previous jobs against it and he will be given the appropriate "rocket" accordingly, but it is unlikely that he will be dismissed. This is one important difference between Public and Private Enterprise.

Relations Between Staff and Works Services

Before describing the methods by which War Office control the expenditure of Works Services, it is necessary to explain the relations between the Staff and the Works Services. It is the duty of the Staff to decide policy, and it is one of the particular duties of the "Q" Staff to decide policy in connexion with Works Services. Therefore it is with this branch that the Engineers must keep in the closest touch, and from whom they get their instructions.

The Engineer has no power whatever to authorize any new works, except for very petty services; he is, in fact, the agent, or if you prefer it the "Bank Manager," for his Commander, who has certain powers and funds allotted to him. It is clear that the agent cannot be entitled to spend his Commander's money without his approval, but when the approval has been given, the Engineer is responsible that the work is carried out strictly in accordance with War Office instructions and scales, according to the specifications and at the appropriate cost. The method of execution is the Engineer's responsibility, and for that reason he is given certain powers of acceptance of contracts.

The chart "A" printed opposite, shows the organization of the Works Services in a Command in the United Kingdom, together with the grade of "Q" Staff Officer, and Regimental Officer with which the various ranks of the Engineer Services normally co-operate. You should notice that the Senior Executive Officer is the D.C.R.E., and that the ranks above him do not actually take charge of any of the works being carried out.

Control of Expenditure

To meet the expenditure on Engineer Services, funds are allotted annually by Parliament in Army Estimates under various sub-headings of Vote 10. Works Services are subdivided into three main headings, which are:—

Part I Services

(*a*) These comprise new works, alterations, and such special repairs as are ordered, costing £10,000 each and over.

Part II Services

(*b*) These comprise all new works, alterations etc., estimated to cost less than £10,000 each.

Part III Services

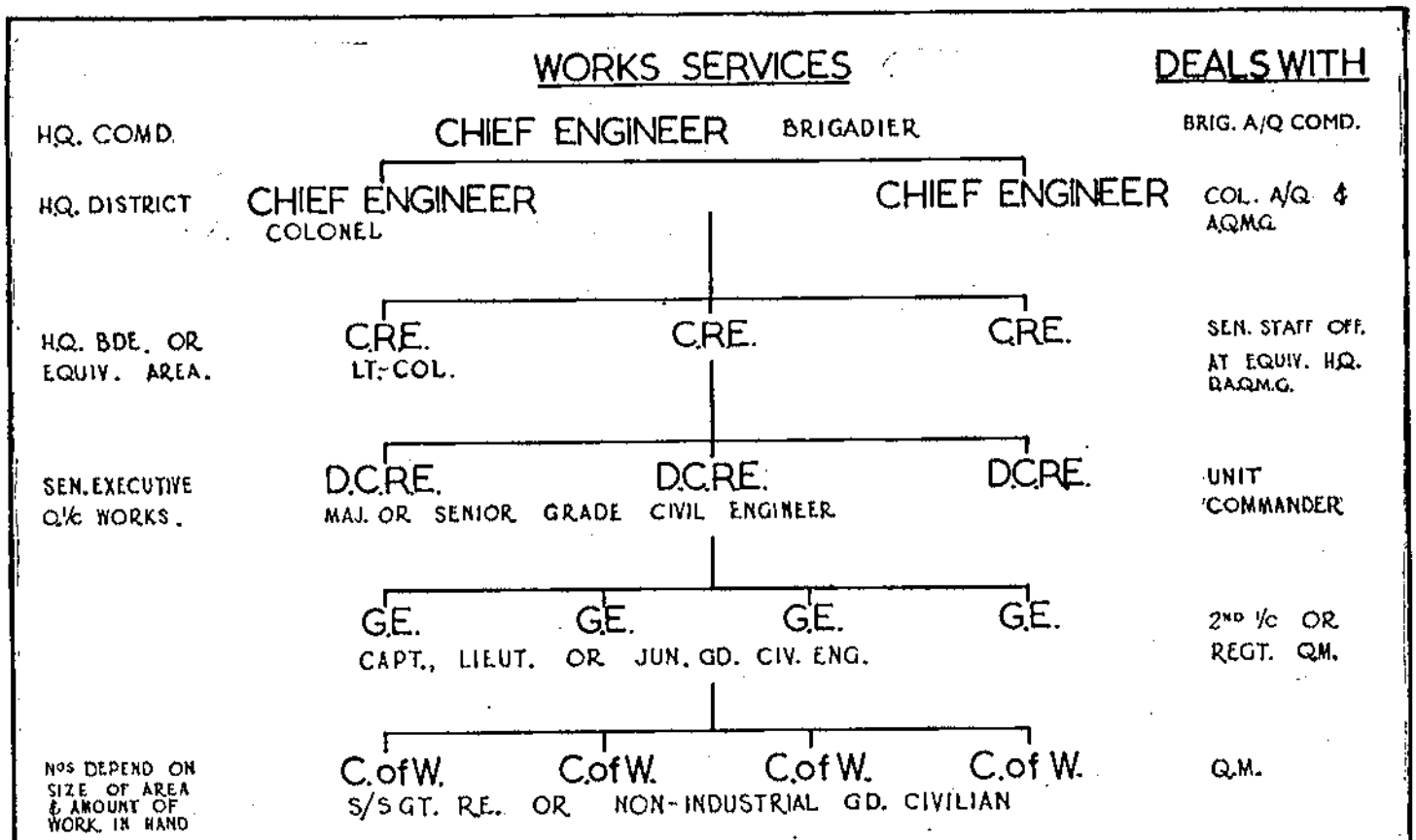
(*c*) These are ordinary repairs, maintenance and renewal services.

Sometimes, when a new Part I service is so large that its period of execution exceeds the limit of one financial year, it is referred to as a Part I Continuation Service, and, in fact, the large majority of Part I Services are Continuation Services.

Generally speaking, funds for Part II and Part III Services are allotted in bulk to Commands, and sub-allotted down to Districts. These have certain limited powers of approval, and this means that the majority, if not all, of Part II and Part III Services do not go to the War Office, but are approved at the appropriate level. For instance, the District power of approval for Part II Services is £500. Services up to that sum will be approved at the District level. In the same way Part III can be approved locally, provided they are within the limits laid down by regulations.

It should be noted, however, that these powers of approval are delegated by the War Office to lower formations, on the understanding that the scales of accommodation laid down by the War Office are not exceeded. If a project, however small, is of such a nature that it exceeds the scales laid down, it should be sent forward for approval.

CHART "A"


WORKS SERVICES
DEALS WITH
H.Q. COMD.
CHIEF ENGINEER
BRIGADIER
BRIG. A/Q COMD.
H.Q. DISTRICT
CHIEF ENGINEER
COLONEL
CHIEF ENGINEER
COL. A/Q & A.Q.M.G.
H.Q. BDE. OR EQUIV. AREA.
C.R.E.
LT.-COL.
C.R.E.
C.R.E.
SEN. STAFF OFF. AT EQUIV. H.Q. D.A.Q.M.G.
SEN. EXECUTIVE O/C WORKS.
D.C.R.E.
MAJ. OR SENIOR GRADE CIVIL ENGINEER.
D.C.R.E.
D.C.R.E.
UNIT COMMANDER
G.E.
G.E.
G.E.
G.E.
CAPT., LIEUT. OR JUN. GD. CIV. ENG.
2ND I/C OR REGT. Q.M.
NOS DEPEND ON SIZE OF AREA & AMOUNT OF WORK IN HAND
C.of W.
C.of W.
C.of W.
C.of W.
S/SGT. R.E. OR NON-INDUSTRIAL GD. CIVILIAN
Q.M.

The guide to the War Office scales is *Barrack Synopsis*. There is a great deal of "loose" thinking about this book, which, if the Engineer is wise, he will keep under lock and key for his own use. There is a mistaken impression that the *Barrack Synopsis* is an authority to bring the old work "up to date," but it is nothing of the sort. It is a guide to the scales of accommodation which should be provided by the Engineer when designing new work, but it is no authority whatever for giving the right to units occupying older buildings to demand comprehensive additions to them in the way of extra accommodation and fittings. In fact, there is a sentence in very large black type in *Barrack Synopsis* to the effect that such demands will not be made unless it is clearly shown in each particular case to be financially justifiable.

Control

As the Engineer Services are entirely spending services, some form of control must obviously be exercised over their activities—we, as tax payers would be the first to complain if this were not the case. There are three essential elements in control which should be thoroughly understood by all "Q" Staff and Engineer Officers dealing with Works Services. These are :—

(*a*) *Administrative Control*

This ensures that the services proposed for execution are :—

(*i*) Of real necessity.
(*ii*) In accordance with War Office policy.
(*iii*) In accordance with the authorized scales.
(*iv*) Taken up for in order of urgency.

(*b*) *Financial Control*

Which ensures that :—

(*i*) No expenditure is incurred without an allotment of funds to meet it.
(*ii*) That funds are only expended on the sevice for which they are allotted.

(*c*) *Technical Control*

Which ensures that :—

(*i*) The design and specification are sound and not extravagant.
(*ii*) The estimate for the work is accurate as far as is possible.
(*iii*) The materials and execution of the work are according to specification.
(*iv*) Payments are made at the proper time in accordance with the conditions of the contract.
(*v*) That accounts are accurately kept.

In order that you should more fully understand these principles, I would like to stress that they are the normal ordinary precautions which every prudent person applies, without exception, to his own private affairs, in order to avoid waste of money and probable bankruptcy.

Take the case of the man who wants to buy a motor car and apply the above principles in his case.

(*a*) *Administrative Control*

(*i*) Does he really *need* the car ?
(*ii*) War Office policy does not, of course, apply.
(*iii*) What sort of car does he want, a Rolls Royce or 1934 Morris Minor ?
(*iv*) Does he want the car more than anything else, say furniture for his house, or a mink coat for his wife ?

(*b*) *Financial*

(*i*) Has he the money to pay for the car ?

(*ii*) Is he spending money which he has earmarked for any other purpose ?

(*c*) *Technical*

(*i*) Is the car in good condition ?

(*ii*) Is the cost known ?

(*iii*) Is the car according to the specification laid down, or is it as good as the seller says it is ?

(*iv*) Have arrangements been made to make payments on the car when they are due ?

(*v*) Accounts may possibly not be kept by private persons, but if a man writes a cheque without knowing what his bank balance is, he may get himself into a mess.

It will be seen, therefore, that all the items apply even to the everyday individual spending his own money. If he is acting as an agent to someone else and not spending his own money, then it is even more necessary to see that all the above conditions are complied with.

The principles of control are, therefore, not useless " red tape," but mere common sense, which is not too much to expect, even in Government Services.

Having discussed the various methods of control, let us now consider their application to a suggested works project.

We will take for an example a Part I Service, i.e., a major project, say the provision of a group of married soldiers quarters, or a scheme for the modernization of existing barrack blocks of the order of £30,000 to £40,000. Once the staff are convinced that the job is necessary, the Engineers are asked to submit a rough estimate of the probable cost. This estimate is usually based on certain data, which is available from past building and which enables the Engineer to give an estimate without a great deal of work. This preliminary rough estimate, or P.R.E., as it is called, is submitted on a special form by the staff through the normal channels to the War Office for approval in principle. If the War Office consider that the project is a sound one, that it is necessary, and that it has a high importance of urgency compared with other projects in the Kingdom, and that funds will be available, they will eventually approve it in principle, and in due course the District H.Q. is informed that it has been so approved.

Once the approval in principle is obtained the Engineers really start detailed work on the project. Drawings have to be prepared according to the scales laid down in *Barrack Synopsis* and approved and signed by all interested parties, including the Medical Services. From the drawings, a detailed estimate of the amount of work under each trade i.e., excavator, concretor, bricklayer, plumber, etc., is made out, and the drawings and the estimate on a special form, i.e., A.F. M.1428, are resubmitted through staff channels for administrative approval and allotment of funds by the War Office. It is at this stage that the plans are checked by the War Office to see that they do, in fact, comply with the regulations as regards scales, that the project is properly designed and that the estimate is as approximately correct as is possible.

If the War Office do not agree with the plans or scales, there will be considerable delays and correspondence and the project will " hang fire."

All this takes time and it may be a matter of six or seven months, and rarely less than three months before the project comes back from the War Office.

On receipt of administrative approval the Works Services Staff have then to prepare the project for contract. This consists of handing the drawings over to the Quantity Surveyors (either a Military Q.S., R.E., or a civilian firm) who prepare the bills of quantities, showing each and every job and every trade which is included in the building. A specification has also to be written giving details of the quality of the work under each trade, which is to be taken up for by the contractor in tendering his prices. Preparation of the bills of quantities takes anything from one month to six or seven weeks and the project is then ready to go out to tender.

By regulations we are supposed to obtain approximately ten to twelve quotations from different firms for each large job, but in these days of shortages and other difficulties, firms are often unwilling to tender, and to obtain the necessary minimum number of quotations it is sometimes necessary to write to something like thirty or forty firms. The contractors are usually given a period of two to three weeks to submit their tenders, depending on the size of the job. The tenders are opened in either the Chief Engineer's office at District or Command, or War Office, according to the size of the job, and are then considered by the Quantity Surveyors' branch.

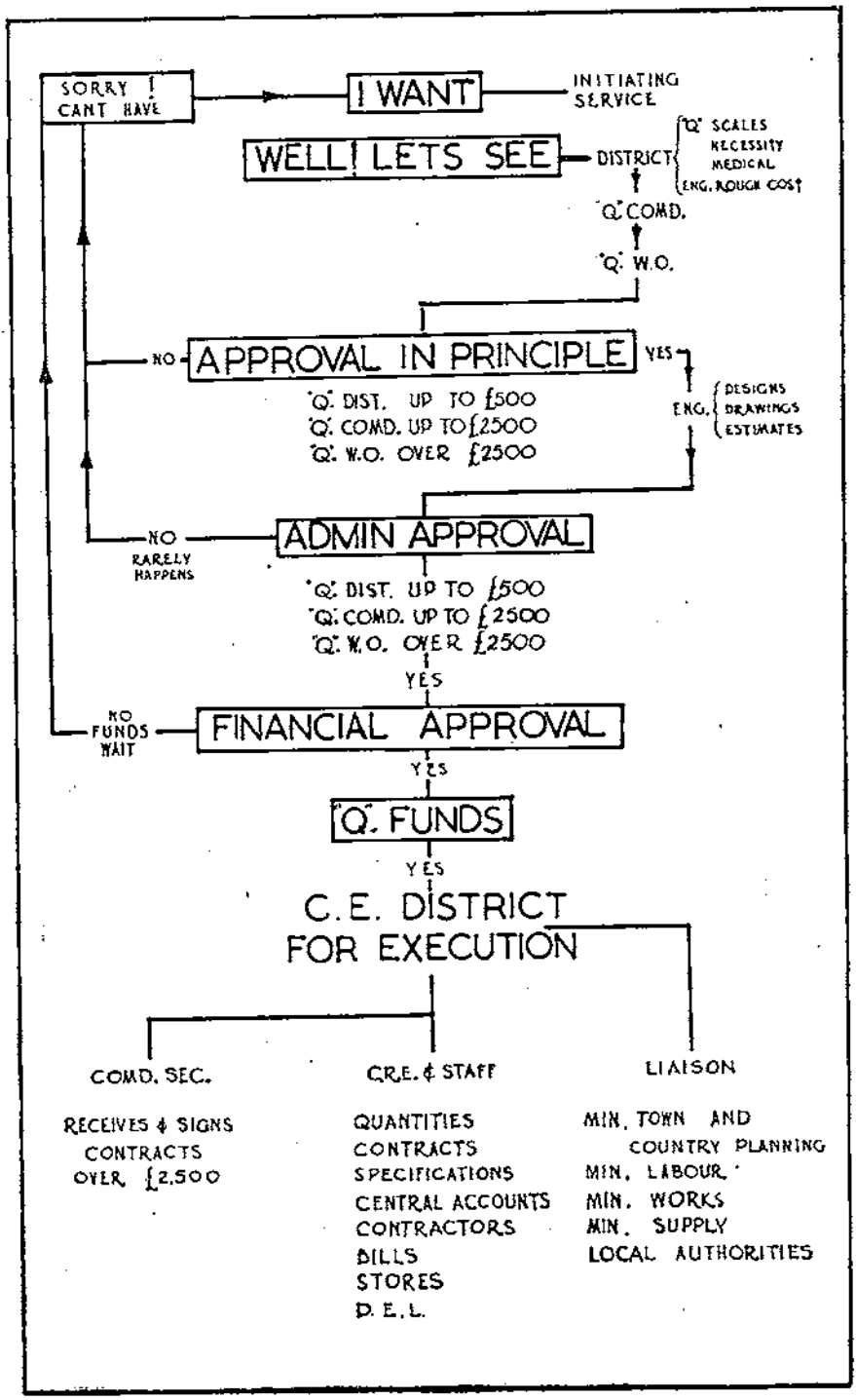
Contractors being human, make mistakes like everyone else and it is usually necessary to go through quite a number of the lowest tenders to make certain their arithmetic is accurate. A careless slip by a contractor's estimating clerk could miss out a one in the thousand column and make a tender appear the cheapest, when in fact it is not. When the tenders are checked they are resubmitted to Command Secretary, or the Director of Contracts, for signature. If the contractor's prices are larger than the estimated cost of the job sent in on the detailed estimate on which the money was approved, there will be further delay while the Finance Department considers the position. Once the contract is signed the contractor is at liberty to start work, and it will be seen, therefore, that before the actual physical start of work on the ground there is an incredible amount of work to be done on the project during the preceding months. In the same way that the start of the Invasion of Europe was not really the 6th June, 1944, but some two years previously when the project was first considered seriously.

Stores

As you know, most building stores are in "short supply" and are the subject of fairly rigid controls. Timber, steel and cement are examples of this, and nowadays it is necessary for the planning side of the Works Staff to make certain that the necessary permits for the release of these materials are obtained well beforehand in order that the progress of work does not suffer through lack of materials. In the days before 1939, when stores were plentiful, this side of the Engineer work was never a very big one and the contractor was usually responsible for putting in samples to the Engineer for approval and making his own arrangements for the supply of the usual building stores. The War Office confined themselves to having running contracts for the supply of certain fittings, which could be bought more cheaply in bulk.

But the position today is very different. In order to obviate delays, a Stores Organization has had to be formed, and as far as is possible a reserve of stores is kept in Command Engineer Depots for use when required.

CHART "B"


SORRY ! CANT HAVE
I WANT
INITIATING SERVICE
WELL! LETS SEE
DISTRICT
'Q' SCALES
NECESSITY
MEDICAL
ENG. ROUGH COST
'Q' COMD.
'Q' W.O.
NO
APPROVAL IN PRINCIPLE
YES
'Q' DIST. UP TO £500
'Q' COMD. UP TO £2500
'Q' W.O. OVER £2500
ENG.
DESIGNS
DRAWINGS
ESTIMATES
NO
RARELY HAPPENS
ADMIN APPROVAL
'Q' DIST. UP TO £500
'Q' COMD. UP TO £2500
'Q' W.O. OVER £2500
YES
NO FUNDS WAIT
FINANCIAL APPROVAL
YES
'Q' FUNDS
YES
C.E. DISTRICT FOR EXECUTION
COMD. SEC.
RECEIVES & SIGNS CONTRACTS OVER £2,500
C.R.E. & STAFF
QUANTITIES
CONTRACTS
SPECIFICATIONS
CENTRAL ACCOUNTS
CONTRACTORS
BILLS
STORES
D. E. L.
LIAISON
MIN. TOWN AND COUNTRY PLANNING
MIN. LABOUR
MIN. WORKS
MIN. SUPPLY
LOCAL AUTHORITIES

Relations with Other Civil Departments

Any large War Office project these days has to take its turn in the queue with other building projects, and has to obtain a Building Licence in exactly the same way as ordinary private work. Normally these licences are applied for about three months before the estimated date of starting. For housing projects this side of negotiations is usually done by the War Office with the Ministry of Health.

If the work is of the nature of a housing estate outside the barrack area, many other departments are interested. Notably, the Ministry of Town & Country Planning, the Ministry of Works, and the local Borough or Urban Councils. If the project involves any road work and includes a connexion to an existing main road, it will be necessary, in many cases, to obtain the consent of the Ministry of Transport to the proposed road layout. Similarly the land may have to be acquired, in which case, the Ministry of Agriculture is almost certain to be interested and may have to give its approval for the use of the land for building purposes. Once the contract is signed and the contractor has his Building Licences, he has to obtain labour by application to the local office of the Ministry of Labour, and in many cases it is necessary for the Engineer Staff to help in these negotiations. It will be seen, therefore, that in these days of controls and planning, considerable liaison with the local ministries is necessary, and it is essential that the relations between the Military Engineer, and his counterpart in civil life are cordial and close.

In a recent project, which is now in hand at Colchester, it was necessary to deal with the Ministry of Town & Country Planning and the County Planning Officer for approval to the layout, with the Ministry of Transport for approval to the road layout, with the Ministry of Agriculture on the question of land, with the Ministry of Works to obtain Building Licences, and labour priorities, with the Ministry of Supply to obtain licence for materials to be used in the buildings, and with the Ministry of Labour to make certain that a sufficient labour force was available. There were also many negotiations with the local Borough Council and Utility Companies for the provision of the services of electric light, power, gas and water. All these negotiations are over and above the procedure laid down by War Office Regulations, which have already been explained to you, and therefore, it is not surprising that under present conditions it takes some time before a job is actually begun on the ground after it is first proposed.

At the beginning of this lecture I said I would end by telling you what I have told you, and the chart " B," which is printed on page 363, explains the procedure in detail which has to be gone through before any large scale project is approved and work can actually start.

I hope that this talk will have put you more in the " Know " than you were before and will explain to you reasons for delays so that you will be more sympathetic with your local engineer when your pet projects appear to be making no progress, for I can assure you that most of the staff of the Works Services are only too keen to do what they can to help you.

SOME EXAMPLES OF THE RECONSTRUCTION OF ROAD BRIDGES IN FRANCE

By Monsieur ANDRÉ RUMPLER

(Directeur des Routes, Inspecteur Général des Ponts et Chaussées)

Reproduction of a paper read at the Institution of Civil Engineers on 11th March, 1948, by kind permission of the Société des Ingénieurs Civils de France and the Institution of Civil Engineers.

BEFORE dealing with the subject of the paper, the author would like to express his very sincere appreciation of the suggestion made by Mr. Aldington, Chief Engineer for Roads at the Ministry of Transport, and transmitted to us by the British Section of the Société des Ingénieurs Civils de France to outline to British Engineers some aspects of the reconstruction of French Road Bridges.

All those who take part in this enormous task must arm themselves with a sense of patience and a sense of perseverance, both of which are being sorely tried by present difficulties. The encouragements we are sometimes given—and your invitation is one of particular value—offer in the course of our daily task a welcome change from the painful awareness of the unlimited number of obstacles which hamper our efforts.

The following figures and general remarks will give an idea of the size of the problem presented by the reconstruction of the road bridges.

During the first stage of the Battle of France, May–July, 1940, 2,531 structures were destroyed forming a gap of an aggregate length of 72 km. (45 miles). The demolitions were located in the area north of the Loire, with some important cuts on the Rhone and the Dordogne. From then onwards until 1st January, 1944, it was possible to rebuild permanently 1,042 bridges and with the exception of some crossings of secondary importance traffic had been restored elsewhere with the help of temporary structures.

The record of the second stage—that of the liberation—is far more impressive: 6,500 bridges destroyed, among them structures already repaired since 1940, with an aggregate length of gap exceeding 150 km. (95 miles). The damage this time is distributed throughout the whole of the country and to the cuts made by the Allies or by the Germans during their retreat must be added those resulting from the activities of the French Forces of Resistance.

The break of communications along the course of the larger streams is practically complete. The situation early in September, 1944, was as follows :—

All the bridges across the Seine, from its mouth up to a couple of miles below Nogent-sur-Seine, were destroyed with the exception of those within the Paris area as well as those at Conflans and at Marcilly ; ninety-four large structures in all. The cuts across the Oise made this situation considerably worse still.

In order to find an undamaged bridge across the Loire, it was necessary to go upstream as far as Nevers ; from Nantes onwards forty-six large road bridges were destroyed.

In the south-east the area of territory from Besançon to the sea, located between the Swiss and the Alpine frontiers on the one hand and the Doubs, the Saone and the Rhone on the other hand, was completely cut off from the rest of France by the destruction of all the bridges across the Rhone, the Saone and the Doubs over the whole of that distance, with the exception of two bridges across the Saone at Lyons ; 148 structures in all.

The area bordering on the Mediterranean was itself cut off from the area just referred to, because of the damage to twenty-one bridges across the Durance, between Avignon and Tallard, with the single exception of the bridge at Manosque which was only partially damaged and allowed a restricted traffic. In addition the cuts across the Var isolated Nice and the Riviera.

It was immediately noticeable that the reconstruction would prove far more difficult than that carried out after the battle of 1940. The shortage of all products, particularly of steel, cement, and means of transport, was heavily felt. However, on 1st December, 1947, the progress of the restoration of traffic was as follows :—

2,300 bridges permanently rebuilt.
510 bridges are in the course of reconstruction.
4,100 temporary bridges and emergency structures are in service, while 107 ferries are also in operation.

The programme of reconstruction as originally drawn up provided for all the bridges to be completely rebuilt within six years, this period being the longest lifetime assigned to the emergency structures. This programme therefore provided for nothing less than for three bridges to be placed into service every day of the year, which illustrates better than any other consideration the magnitude of the task to be assumed by the Department of Roads and Bridges.

The fulfilment of this programme had started in a satisfactory manner, considering that up to 1st January, 1947, 1,747 bridges had been permanently rebuilt.

For reasons which are so much public property that they need not be developed in detail, a considerable reduction in our rate of output has taken place, so that difficult problems will shortly arise in connexion with the maintenance of the emergency structures.

However, the expenditure carried out up to the end of 1947 amounts to 14,000 million francs (£30 million) and the works still remaining to be carried out are estimated to cost 40,000 million francs (£80 million).

Converted into French francs at 1947 values, the total expenditure will amount to some 70,000 million francs (£140 millions).

As regards the materials subjected to quotas, their quantities amount to :—

450,000 tons of steel.
1,110,000 tons of cement,
725,000 m^3 (91,000 London Standards) of timber.

This briefly summarizes the magnitude of the work involved in rebuilding the French road bridges. This reconstruction has presented many engineering problems and this paper will be limited to discussing some details of three types which may prove of particular interest to you.

Reconstruction of Metal Bridges by Raising the Collapsed Components

As originally indicated the reconstruction of the French road bridges has been and is being carried out subject to the present many shortages.

Therefore, whenever an improvement of the characteristics or the accessi-

bility of a given structure was not called for, every endeavour has been made to use for the reconstruction as much as possible of the undamaged components such as the abutments and piers, decking units, etc.

The raising of the decking of the larger structures required special arrangements on site, of which two examples will be given.

Pirmil Bridge

This structure across the southern arm of the Loire at Nantes was the largest steel cantilever in the whole of France ; 2,300 tons of steel had gone to building the framework while the decking beneath the 14·50 m. (49 ft.) wide roadway was of reinforced concrete. The collapsed sections were duly raised and then reassembled so as to rebuild the original framing, only 400 tons of new steel being necessary, which means that it proved possible to salvage 80 per cent of the original weight.

The northern cantilever was raised by means of jacks carried on timber trestles.

The most difficult operation was the salvage of the suspension truss having a weight of 900 tons which had fallen flat to the bottom of the river. It was lifted by means of barges of the dredger service and landed on high ground so that at low tide it could be cleared of its concrete cover.

The weight having thus been reduced to 300 tons, that is the weight of the steel framing alone, the truss was brought back to its original location using the same barges and lifted by means of telescopic shafts inch by inch until it reached the correct level, when it was permanently linked up with the appropriate north and south cantilevers.

The roadway of the bridge, which had previously been of wood pavement, has been remade in stone mosaic pavement as this offers better resistance to wear and is far less slippery.

The cost of reinstatement is 110 million francs of 1947 value (£220,000). The cost of a new structure would have been 165 million francs (£330,000) to which should be added the charges for clearing the river bed estimated at 30 million francs (£60,000).

The method of reconstruction adopted therefore not only allowed the salvage of 1,900 tons of steel previously mentioned, but also a saving in costs of 85 million francs (£170,000).

Figures 1 to 10 show details of the work and the appearance of the bridge after reconstruction.

The Gallieni Bridge at Lyons

Within the comparatively short period from 1888 to 1903 four large metal bridges had been erected over the Rhone at Lyons. These bridges are 20 m. (66 ft.) wide and their length of slightly over 200 m. (say 700 ft.) is subdivided into three openings, each of which consists of eight arches below the decking, their span varying from 62·60 m. (205 ft.) to 72·50 m. (238 ft.). For their foundations compressed air caissons had been used. Of similar design, similar means were used to blow them up. The piers had only been subjected to the reaction of the destruction of the decking by surface charges, the arches destroyed had, with the exception of one, retained a certain amount of cohesion and each semi-arch seemed to rest fairly level on the river bed.

Their rapid reconstruction is mainly due to the raising of the collapsed part as a single whole, and the Gallieni bridge furnishes the most typical example of the operations necessary for this work.

Fig. 11 shows the appearance of the collapsed arch on the 3rd September, 1944, following the destruction.

In view of the magnitude of the problem to be solved it appeared desirable to set up a standard method which could be applied to each one of the four structures in turn, as among other advantages this would allow the release at a favourable rate of the special equipment necessary for the work involved. Right from the start it was decided neither to cut nor to clear the wreck in sections. The raising as a whole being next considered, considerable difficulties became immediately apparent, because :—

(*a*) The wreck, in addition to its fall, had suffered a double horizontal displacement, one in the lengthwise direction because of the scouring of the gravel making up the river bed, the other in a crosswise direction due to the current.

(*b*) The possible points of attack for the raising operation were far less clearly defined on account of the number of arches, than would have been the case for a structure with main girders, and it was not possible to have the advantage of a balance arm as with a cantilever.

(*c*) The flow of the Rhone is of torrential character, so that it was also impossible to make use of the bearing powers of barges fitted with water ballasts.

From an inspection of the parts emerging above water it appeared that the arches had not suffered a general distortion and that as the cut at the crown had not been completed, the two semi-arches had remained joined together. It might have proved possible to finish this cut by under-water explosion, but this method would have certainly entailed very heavy damages. It was, therefore, necessary to consider raising the two semi-arches as one solid whole. Relieved as far as possible of any dead loads, it was still a mass of 800 tons that had to be raised. No lifting appliances for exceptionally heavy loads being available to the engineers for this operation, it was necessary to make use of appliances of average lifting power and therefore to subdivide the mass of the arches and to multiply the points of support. In addition to those at the springers, two others at one third and two-thirds respectively of the span were also provided.

It was quite out of the question to provide one system of pile trestles on the up-stream and one on the down-stream sides of the bridge as it would have necessitated lifting beams with a span exceeding 22 m. (say 70 ft.) between such supports. It was therefore necessary to drive the piles through the decking within the space left clear between the eight arches. Their position was plotted with the greatest possible accuracy in order to allow for all the movements of the wreck ; rotation around a horizontal centre-line, length and crosswise shifting.

Fig. 12 shows a general diagram of the lifting appliance. The necessary openings were provided in the decking, either by cutting with an under-water oxy-acetylene flame or by means of explosive charges laid by a diver. The space available was very restricted, which had the double disadvantage of increasing the effect of any error in driving the piles and of reducing the base of the trestles, which made them very susceptible to the impact of the flow. It was, therefore, decided to reduce the height of the trestles, which entailed proceeding in two stages, the first being limited to the withdrawal of the arches from the river, while after the height of the supports had been suitably increased, the second stage would see the arches raised to their permanent level.

The lifting arrangement set up consisted of shears erected on the trestles, each one carrying a balanced lever by means of cables ; on the banks of wedges and rollers ; on the trestles the arches were anchored to transverse

beams subject to the pressure of the jacks, so that the suspension of the arches made up a parallelogram able to suffer distortions. Fig. 13 shows this arrangement in detail.

The operation was controlled in such a manner as to ensure hoisting speeds which differed for each support while the lift was uniform throughout. It was therefore necessary to co-ordinate the forces applied by fifty-six men to four hand winches of 7 tons each and of sixteen jacks of 50 tons each.

One of the difficulties encountered was the heavy deposit of gravel on the centre portions. A fairly heavy overload might therefore oppose the removal of the decking and of the arches at the start of the operations. Once the decking had left the river bed there was no longer any impediment to reduce the current and should a flood intervene, then the whole of the trestles might be carried away.

The actual raising operation was started early in May, 1945, after a period of floods and of frosts which had seriously interfered with the work. One month later the first stage was practically completed and the wreck had been completely withdrawn from the river. Fig. 14 shows the position on site at that time with the arch raised out of the water.

The second stage was completed at the end of August. Fig. 15 is a view of the site taken in July during the course of the second stage. For seven of the eight arches the gap at the crown had been reduced to a length of 5 m. (16 ft. 6 in.) to 6 m. (20 ft.), but the distances between the centres of the supports varied.

Following the absence of the thrust acting on one of the faces of the pier, a new stable state of equilibrium had developed, but the foundation had shifted and the adjacent arch had suffered a drop of 7 cm. ($2\frac{3}{4}$ in.).

The corresponding closing in of the supports of the arch to be rebuilt was taken up on the one hand by planing down the adjusting keys of the hinge, and on the other by adjusting the closure at the crown so as to provide a superelevation of 11 cm. ($4\frac{21}{64}$ in.) above the 5 cm. (2 in.) corresponding to the deflection of the crown under the dead load. These provisions ensured the closure at the crown being carried out without any particular difficulty.

Fig. 16 shows the arches back in position. The roadway provided consists of 6 cm. ($2\frac{3}{8}$ in.) thick coat of bituminous asphalt laid on a roadbed of concrete with puzzolana aggregate, which allowed the specific gravity to be kept as low as 1350/1500 kg./m^3 (85/95 lb./cu. ft.).

It has thus been possible to repair this important structure, having a total weight of 720 tons for the destroyed arches alone, with only 85 tons of new steel brought in, of which 30 tons were used for local repairs which cannot be fully ascribed to the demolition.

The total cost of the works was 9·8 million francs (£20,000) of which 5·7 millions francs (£12,500) were for clearing the site.

Bridges in Prestressed Concrete

The rebuilding of some 7,000 bridges offered a particularly favourable field for the study of the best application of prestressed concrete structures.

There were many instances among the works scheduled for reconstruction where either the span or the necessary clearance justified the adoption of new systems. Moreover prestressing appeared to ensure considerable saving of materials.

This system was therefore adopted with all the confidence necessary to assure its success, allied with the pioneer spirit called for when implementing new methods. The main principles of prestressing have been the subject of so many papers that it appears unnecessary to recall them at this stage.

Quotations will, however, be made from a paper by M. Freyssinet, the engineer who had the genius to carry the development of prestressing right through from the initial theoretical discussions to its execution including the accurate setting up of the tools and site organization required.

These quotations clearly state the essential features of this new method of construction :—

"The basic principle of reinforced concrete prevents any possibility of improvement because in reinforced concrete the steels are not used according to their own tensile strength but according to the ability of the concrete to follow the steel strains ; also, because the compressions of the concrete are related to the ratio of its own strain to that of the reinforcement. In other words, the reinforcement subjects the concrete to its own strain. In prestressed structures the compression in the concrete of the tensile zone is released under load, subjecting the steel to its own very small strain. It follows, therefore, that the steel stresses which are practically free from the influence of the load, can be taken as constant once the slow distortions of the materials have taken place, which ensures the best possible use of all the qualities of the steel. Similarly the concrete section is fully used in a manner which is infinitely superior to that of reinforced concrete."

Prestressing has been applied to twelve road structures either already in service or on the point of completion, this number not including the many short-span emergency or permanent structures for which factory-produced beams have been used.

The first two in chronological order are slab bridges having spans of 10·50 m. (34 ft. 5 in.) and 20.50 m. (67 ft. 3 in.) respectively, one being located at Elbeuf-on-Andelle, the other crossing the Bresle at Longroy. Their erection was carried out in 1942 and they are of particular interest in that they provide a testing ground for the study of the behaviour of concrete and reinforcement, and of the best possible methods of using the two constituent materials, as well as of the equipment necessary on site.

The slabs designed vary in thickness from 0·35 m. (1 ft. 2 in.) along the longitudinal centre line to 0·30 m. (1 ft.) at the gutters for the 10·50 m. (34 ft. 5 in.) span, and from 0·69 m. (2 ft. 3 in.) to 0·66 m. (2 ft. 2 in.) for the 20·50 m. (67 ft. 3 in.) span. Because of their reduced thickness, and with materials of present-day qualities, structures of this type may be used for spans up to 25 m. (82 ft)., and are especially attractive for cases where a saving in the thickness of the decking is of more importance than any possible saving on the cost of the decking itself. This case occurs fairly frequently when it is necessary to provide a given clearance above a water course, a road or a railway, while the upper level of the roadway is definitely set because of the conditions of access to the structure. Static and dynamic tests have shown the great rigidity of such slab structures.

In the case of the Longroy bridge, after a unit live load of 900 kg. per m^2 (185 lb. per sq. ft.) of slab had been uniformly applied for 24 hours the deflection recorded was 9 mm. ($\frac{11}{32}$ in.), while no permanent deflection remained after the load had been removed.

The saving in materials may be gauged from the following comparisons worked out for a similar slab of 14 m. (46 ft.) span :—

Reinforced concrete bridge of normal depth [1·06 m. (3 ft. 6 in.)] ; 64 m^3 (84 cu. yds.) of concrete, 15·5 tons of steel.

Reinforced concrete bridge of reduced depth [0·78 m. (2 ft. 7 in.)] ; 66 m^3 (86·5 cu. yds.) of concrete, 20 tons of steel.

Prestressed concrete slab bridge : depth [0·48 m. (1 ft. 7 in.)] ; 55 m^3 (72 cu. yds.) of concrete, 4·5 tons of steel.

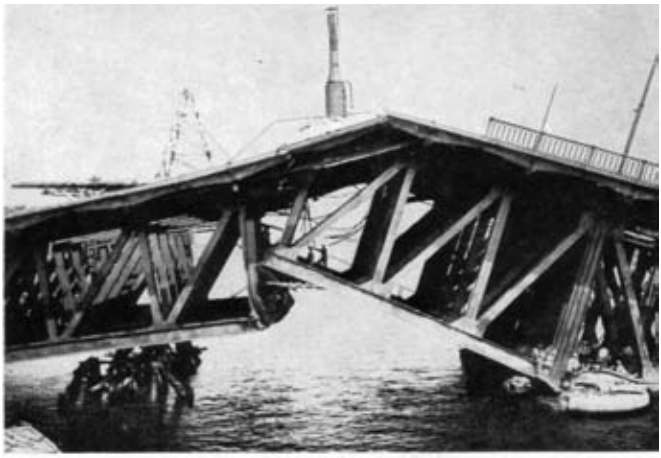


FIG. 1.—Note the distortion of the lower boom folded back over one panel.

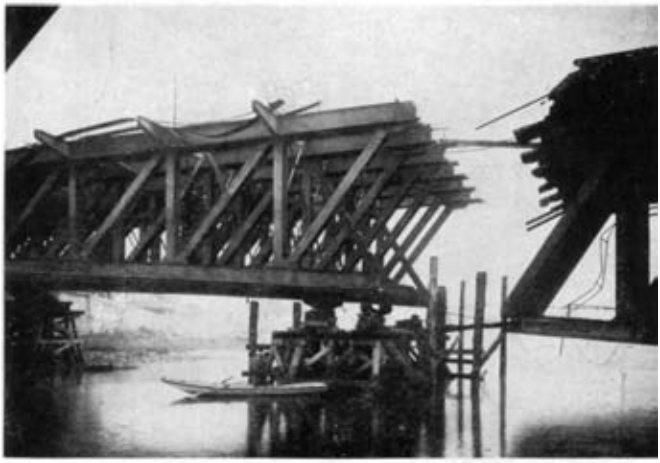


FIG. 2.—The balance arm of the north cantilever after it had been raised and repaired.

Pirmil Bridge at Nates 1,2

FIG. 3.—The general arrangement of the equipment used for raising the north cantilever.

FIG. 4.—The first displacement of the suspension truss in preparation for its raising. The linked-up barges are grounded against the truss.

Pirmil Bridge at Nates 3,4

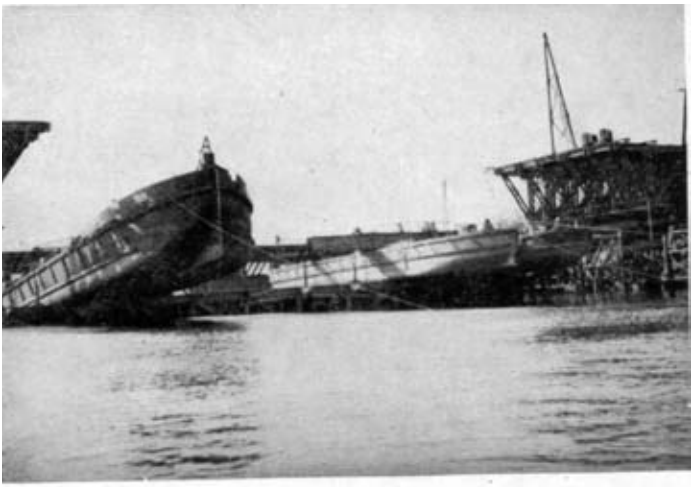


FIG. 5.—The second displacement, the barges are again grounded against the truss.

FIG. 6.—The truss at low water after its second displacement.

Pirmil Bridge at Nates 5,6

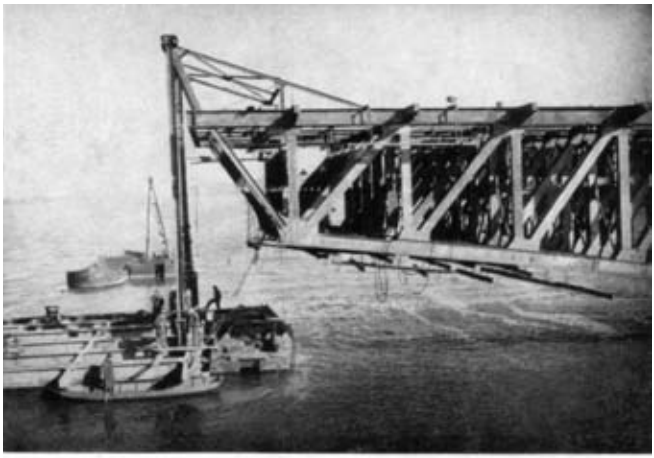


FIG. 7.—One of the equipments used for the final lifting operation of the truss —telescopic shafts with rack and jack at the bottom end.

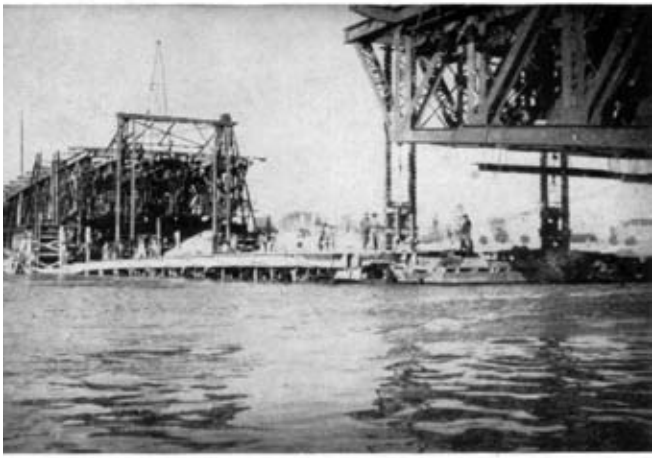


FIG. 8.—The raising on site at the start of the operation.

Pirmil Bridge at Nates 7,8

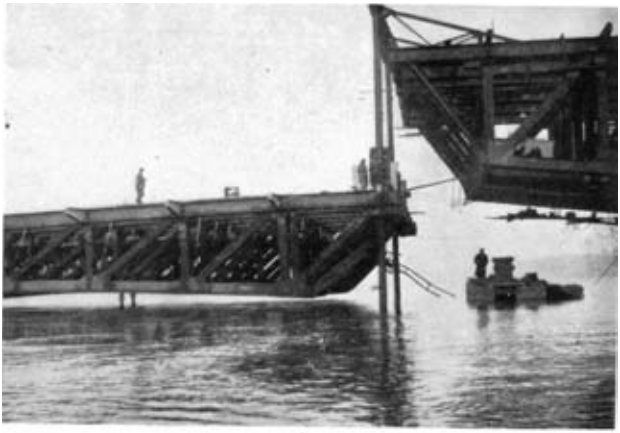


FIG. 9.—The truss raised to half of the total height to be covered.

FIG. 10.—The general appearance of the bridge after reconstruction.

Pirmil Bridge at Nates 9,10

FIG. 11.—Collapsed arch as on 3rd September, 1944.

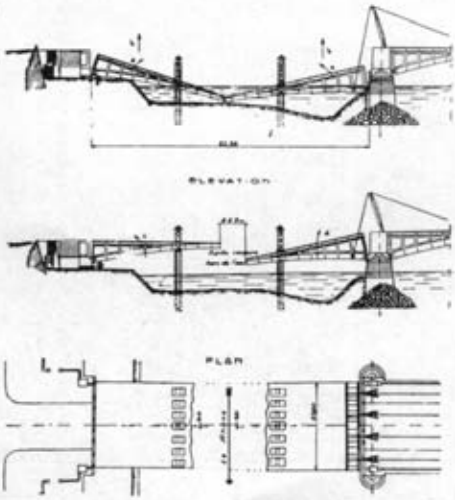


FIG. 12.—General diagram of lifting apparatus.

Gallieni Bridge at lyons 11,12

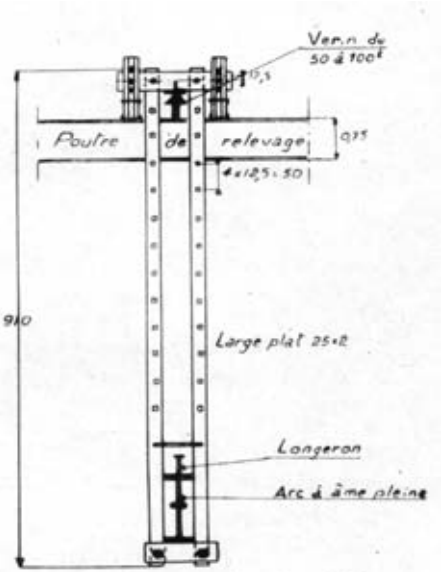


FIG. 13.—Arrangement of trestles and jacks.

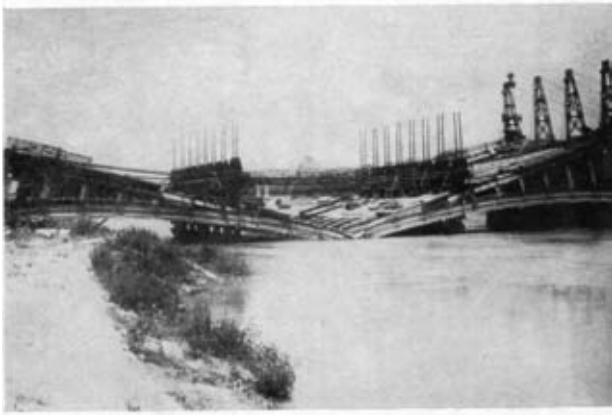


FIG. 14.—Arches raised out of the water.

Gallieni Bridge at lyons 13,14

FIG. 15.—Lifting arches to final position.

FIG. 16.—Arches back in final position.

Gallieni Bridge at lyons 15,16

FIG. 17.—An up-stream view of the finished bridge.

FIG. 18.—The general arrangement of the structure.

Hermillon Bridge 17,18

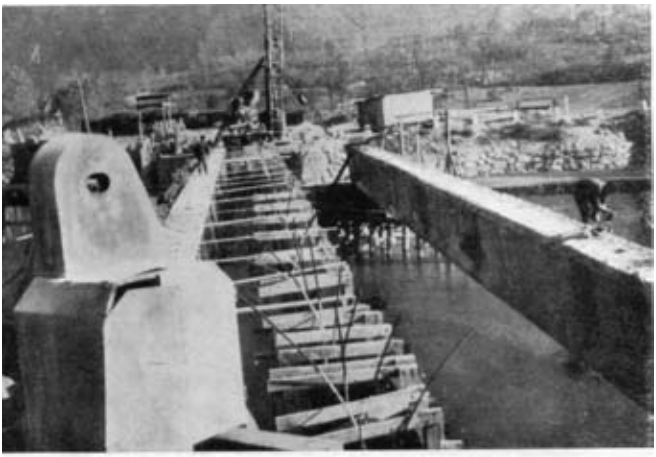


FIG. 19.—The first beam cast has been shifted to the right in order to clear the concreting stage.

FIG. 20.—The final placing of the beams. The two beams on the right have still to be shifted. Note the cables for transversal prestressing passing through the top flanges.

Hermillon Bridge 19,20

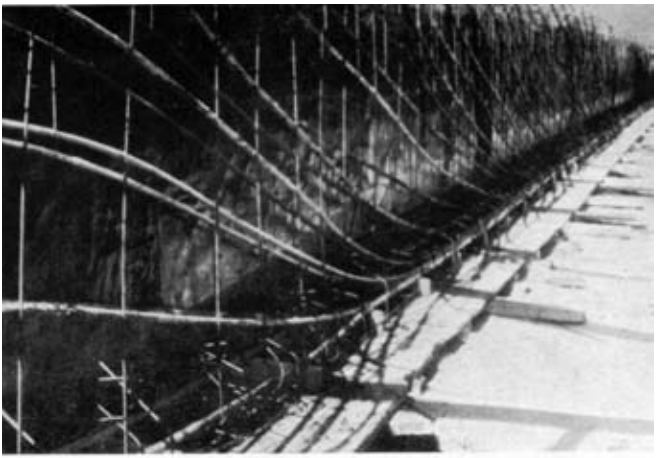


FIG. 21.—Reinforcement for beams.

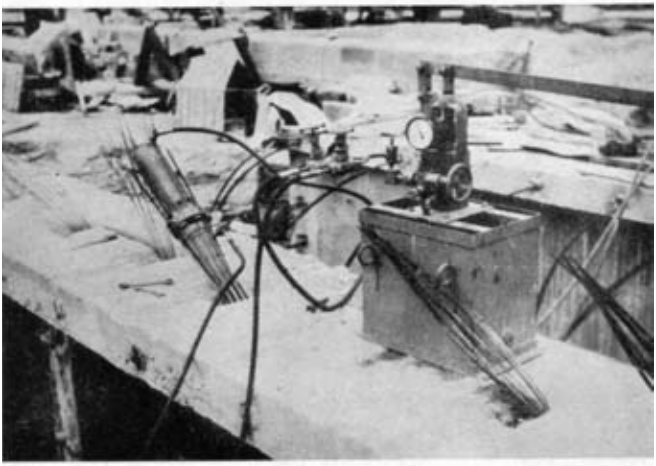


FIG. 22.—The jacks and pumps. Note the lifted ends of the cables anchored on the upper flange of the beams.

Hermillon Bridge 21,22

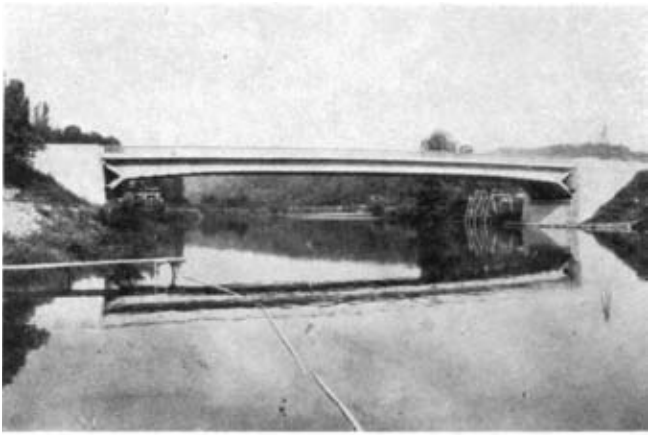


FIG. 23.—The completed prestressed concrete bridge.

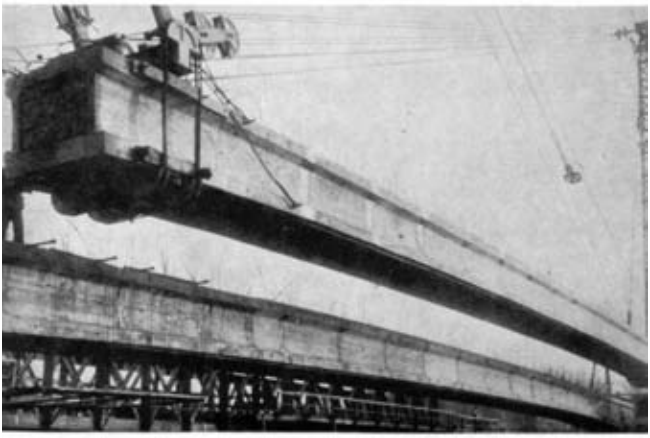


FIG. 24.—Launching the girders.

Luzancy Bridge 23,24

FIG. 25.—Moulds and organization for casting.

FIG. 26.—Finished voussoirs and arrangements for storage and transport

Luzancy Bridge 25,26

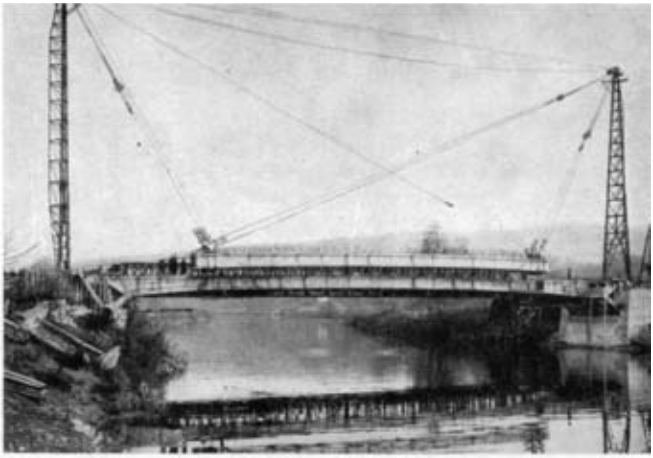


FIG. 27.—Cable conveyors for launching girders.

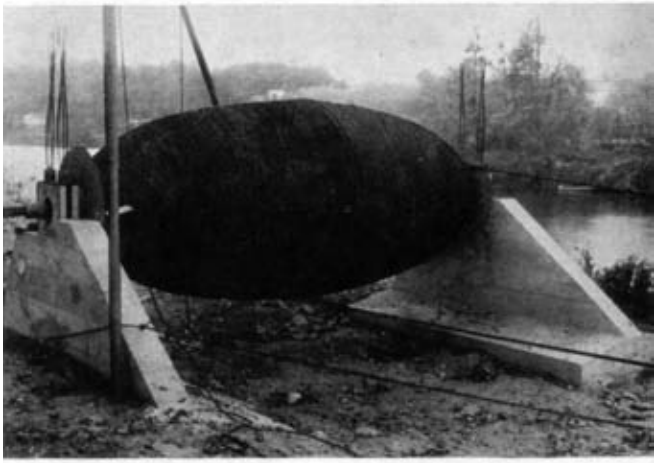


FIG. 28.—Special equilibrating drum for cables.

Luzancy Bridge 27,28

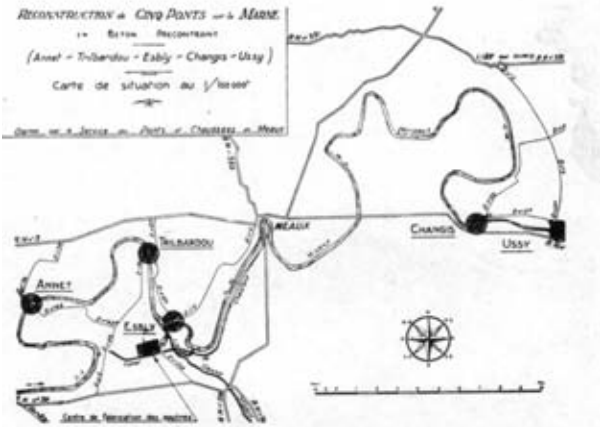


FIG. 29.—Sites selected for five prestressed concrete bridges over the River Marne.

ESBLY BRIDGE

FIG. 30.—An artist's impression of this prestressed concrete bridge.

Esbly Bridge 29,30

PONT-DE-L'ARCHE BRIDGE OVER RIVER EURE

FIG. 31.—A " Mulberry " component bridge.

METZ BRIDGE

FIG. 32.—A " Mulberry " component bridge showing footpaths and hand-rails.

Pont-de-larche Bridge over river eure, metz bridge 31-32

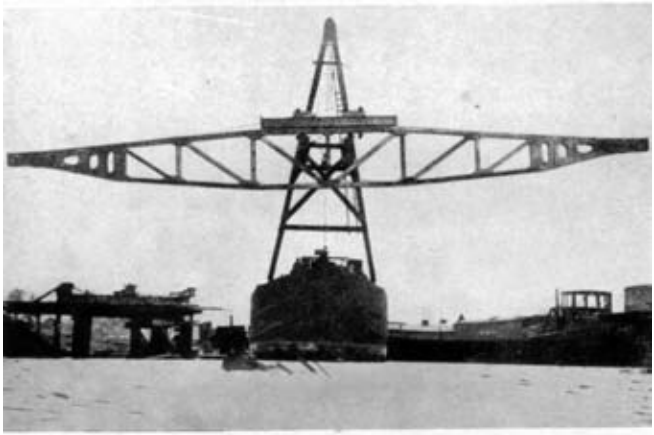


FIG. 35.—Floating sheer legs for erecting girders. Note. " Mulberry " girder lengthened at both ends.

FIG. 36.—The completed structure.

Pont-de-larche Bridge over river seine 35,36

FIG. 37.—" Mulberry " spans carried on concrete trestles.

FIG. 38.—The completed structure.

Chatel-De-Neuvre-Bridge 37,38

FIG. 39.—" Mulberry " component lengthened by the insertion of a central cross-braced panel.

PORT-BOULET BRIDGE

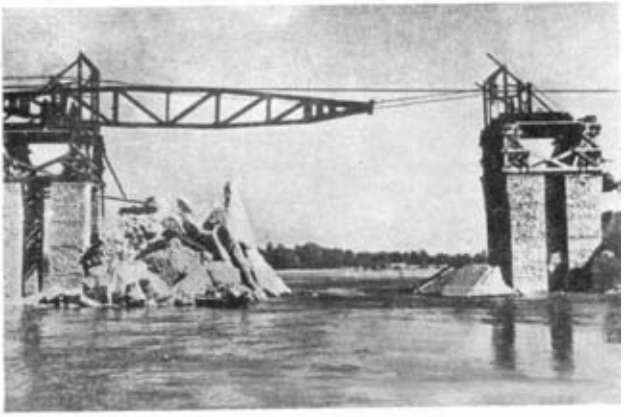


FIG. 40.—Cables guiding the front of the girder, which rested on a trolley at the rear.

Taillebourg Bridge, Port-Boulet Bridge, 39,40

CONFLANS-FINS-D'OISE BRIDGE

FIG. 41.—Erecting " Mulberry " girders.

LA ROCHE-BERNARD BRIDGE

FIG. 42.—The site and remains of old bridge.

Conflans-fins-D oise Bridge, LA Roche-Bernard Bridge 41,42

FIG. 43.—The completed bridge.

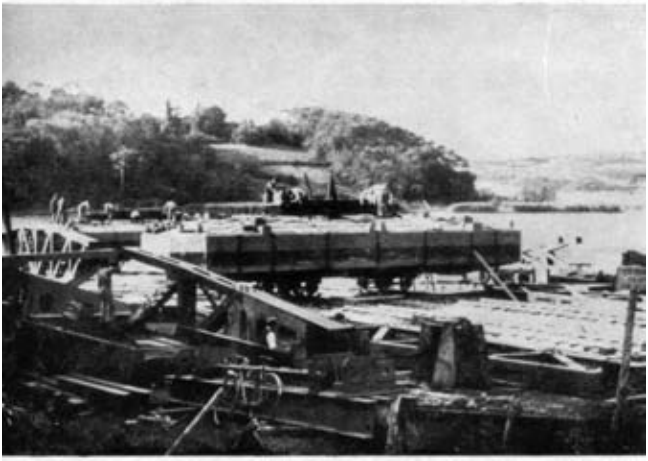


FIG. 44.—Erecting the girders on pontoons on a slipway.

LA Roche-Bernard Bridge 43,44

Some details will now be given of two structures which have been selected as offering the greatest interest of all those erected in prestressed concrete, following the construction of the two large slab bridges in the Department of the Seine Inférieure :—

The Hermillon Bridge

This structure is located in Savoy and affords the "Route Nationale" No. 6 a crossing over the river Arc.

It is a 40-deg. skew bridge and the true span of the beams is 51·40 m. (168 ft. 7 in.). The roadway is 9 m. (29 ft. 6 in.) wide and there are two footpaths 1·50 m. (5 ft.) wide each.

The structure consists of ten similar beams at 1·15 m. (3 ft. 9 in.) centres. These beams are provided with flanges at top and bottom ; the greater part of the decking is made up from the 1 m. (3 ft. 3⅛ in.) wide compression slabs, the 0·15 m. (6 in.) wide spaces in between being concreted *in situ*.

The overall height of the beams increases from 2·20 m. (7 ft. 3 in.) at the bearings to 2·40 m. (7 ft. 11 in.) at the centre. The web has an average thickness of 0·12 m. (4¾ in.), while in the vicinity of the bearings this thickness is increased by gussets up to 0·50 m. (1 ft. 8 in.), this dimension being maintained right through to the end.

The volume of concrete in each of these beams is 40 m³ (52·5 cu. yds.). The beams are connected by eight cross beams parallel to the abutments. Pendulum bearings at right angles to the beams and tapering down 1 in 7 toward the bank are used for the hinge at the free end. Each beam was cast separately on a staging erected along the centre line of the structure and then shifted sideways over its bearings, on to which it was let down with jacks.

Figures 17 to 20 show details of the bridge and the beams.

The cables were arranged inside the mould and securely held in position, in order to avoid any movement during vibrating. They were held at their ends by anchorage cones temporarily fixed to the shuttering.

When the concrete had sufficiently matured, the longitudinal cables were stretched and fixed by means of cones set in the concrete.

The stress to be set up in the cables is 100 kg./mm² (63·5 tons/sq. in.) in order to assure the permitted permanent stress of 85 kg./mm² (54 tons/sq. in.) after release.

Figures 21 and 22 show details of reinforcement and the jacks.

The total reinforcement of this structure amounts to 28 tons of high tensile steel cables and 14 tons of ordinary mild steel for reinforced concrete (stirrups, springer reinforcements, etc.).

For the sake of comparison it should be noted that a bow-string having the same span and of the same width would have required 200 tons of steel.

The Luzancy Bridge

This structure is located in the Department of Seine-et-Marne and affords the "Route Nationale" No. 369, which follows the valley of the Marne, a crossing over this river.

The conditions imposed by the topography of the site and the requirements of navigation were particularly severe. For a span of 55 m. (182 ft.) only 1·30 m. (4 ft. 3 in.) were available between the clearance required for navigation and the crown of the road.

The use of prestressed concrete made it possible to meet this difficult problem. The structure thus obtained is of very clean design and harmonizes well with a landscape which has been sufficiently valued by artists for it to be patronized by painters as famous as Corot.

As shown on Fig. 24, the bridge consists in the main of three hollow portal frames, so flat as to rise only 1 in 23 from the centre line of the hinges to the intrados of the crown section. Each of these girders is made up from twenty-two precast blocks assembled together by steel reinforcement.

Placed at a distance of 0·90 m. (2 ft. $11\frac{7}{8}$ in.) from each other, the three frames are joined by decking, also precast, the thickness of which varies in the same manner as that of the top flange of the girders, the whole being assembled by transverse prestressing cables.

Fig. 24 was taken during the launching of one of the girders and shows their structure. The frame legs are made up from three triangular systems and are supported on hinges, themselves carried by extra flat adjusting jacks which can be used at any time to regulate the thrust and concrete stresses, and compensate shrinkage or any possible movement of the abutments.

As mentioned previously the girders consist of precast voussoirs weighing approximately 5 tons each. This method of construction presents many important advantages :—

(*a*) Positive control of the quality of the concrete, the resistance of which always exceeds 470 kg./cm² (6,700 lb./sq. in.). After forty-one months the resistance of the concrete varied between 600 kg./cm² (8,500 lb./sq. in.) and 800 kg./cm² (11,400 lb./sq. in.).

(*b*) Reduction of 90 per cent in the quantity of timber required for shuttering as the moulds had been designed so that they could be used scores of times without having to be rebuilt.

(*c*) Assembly on the banks, of the girders having a weight of 112 tons each, from components having already taken most of their shrinkage.

(*d*) Avoidance therefore of the necessity for any centering and/or scaffolding in the river.

Fig. 25 shows the moulds and the organization of the site for casting the voussoirs. The concrete was vibrated by means of two " Vibrogir " vibrators of 6 tons impact each, rotating at 2,800 r.p.m. In addition 1 m. (3 ft. $3\frac{3}{8}$ in.) high funnels allowed the final casting of the concrete to be made under pressure.

Fig. 26 shows the finished voussoirs and arrangements on site for their storage and transport to the point of assembly of the girders. After the voussoirs—twenty-two for each girder—had been placed alongside each other, the 2 cm. ($\frac{25}{32}$ in.) thick joints were filled with mortar having a cement content of 800 kg./m³ (50 lb./cu. ft.), mixed very dry and well caulked.

The cables were then brought into position and stretched cold to 115 kg./mm² (73 tons/sq. in.) with an elongation corresponding to only 64 kg./mm² (40·6 tons/sq. in.).

The girders were launched by means of a cable conveyor (Fig. 27), derived from the standard lifting method using two load masts with pulley blocks and which includes a particularly suitable system for winding the cables on to a specially designed drum, so that the only energy required is that necessary for overcoming the friction losses.

Fig. 28 shows this special equilibrating drum which consists of two hollow concrete half shells, joined together by a prestressing cable at the centre.

The construction of the other parts of the structure, such as decking, roadway, etc., will not be discussed in detail and this short monograph will be completed by a few words on the results obtained at the tests and on the savings the application of prestressing made possible in this particular case.

A load of 400 kg./m² (82 lb./sq. ft.) on the footpaths and of twelve motor lorries on the roadway, making up a total weight of 244 tons was provided on the bridge.

The deflection recorded along the centre line amounted to 26 mm. (1 ft. approx.). Two motor lorries of 20 tons and 25 tons, running at a speed of 20 km./h. (16 m.p.h.) caused a deflection of 6 mm. ($\frac{1}{4}$ in. approx.). The structure is therefore particularly rigid.

As regards the savings of materials, these will be fully appreciated from a comparison with the structure existing prior to its destruction in 1940, and which was of the three-hinged inverted arch type. Its width overall was 6·30 m. (20 ft. 9 in.) as against 7 m. (22 ft.) for the new bridge. Moreover, the specified live loads, which were 400 kg./m^2 (82 lb./sq. ft.), are now double this value. Notwithstanding these improved characteristics the volume of concrete has been reduced from 300 to 270 m^3 (392 to 353 cu. yds.), while the quantity of steel dropped from 140 tons to 14 tons.

The experience acquired with the introduction of prestressing, and particularly that resulting from the Luzancy bridge, leads to the two conclusions that not only is this system of construction able to provide new solutions for difficult crossing problems, but also that it ensures considerable saving of materials.

However, the special attention required as well as the large equipment necessary on the site made it appear doubtful whether this system would be able to compete successfully on a cost basis with existing methods of construction. More particularly it had become evident that the timber shuttering at present in use for the precast units deteriorated so considerably in service that it would prove expedient to use steel shuttering. However, the cost price of such steel shuttering represents approximately 25 per cent of the total cost of the structure.

It was, therefore, of interest to draw up a programme for the reconstruction in parallel of several bridges having nearly all the same characteristics so that prestressing should stand an equal chance when compared with other types of work. Such a favourable opportunity presented itself when rebuilding five bridges across the Marne located within a maximum distance of about 10 miles on either side of Meaux.

The black circles on Fig. 29 indicate the position of these bridges. The black oblong indicates the site selected for the main working centre which adjoins Esbly and is alongside the Canal.

The conditions of tender left the greatest freedom to the contractors with regard both to single or multiple span structures, and to the choice of the materials to be selected for the construction. The prices quoted for the erection of the bridges in prestressed concrete were about 5 to 15 per cent lower than those for their counterparts in reinforced concrete, while assuring a considerable saving in steel, cement and timber, presenting a better appearance and improved conditions for the water flow.

The new structures will not be sensibly different from that at Luzancy, of which they are an enlarged development, having a span of 76 m. (250 ft.) instead of 55 m. (182 ft.).

Fig. 30 gives an architect's impression of the Esbly bridge. Compared with reinforced concrete the weight of the new span will be 800 tons instead of 1,700 tons and will only require 12 tons of high tensile and 17 tons of mild steel instead of 120 tons of mild steel.

The site will be organized along the following general lines. At Esbly the main working centre will prepare all the precast units by casting them in steel moulds, where they will be vibrated and slightly warmed up in order to accelerate the hardening of the concrete, so as to assure a quicker turn round of the shuttering. A travelling crane will shift these unit blocks to an assembly floor where they will be made up into girders which will be shipped on canal

barges to the different sites where they will be placed into position using similar methods to those employed at Luzancy.

It was expected to launch the first of these bridges at the beginning of 1948.

Structures Embodying Mulberry Flexible Bridge Spans

Our steady efforts to make the best possible use of any material at our disposal found a particularly wide range of application for "Emergency" structures of the Calendar-Hamilton type or of military bridge spans which His Majesty's Government was good enough to hand over to us. The author is especially pleased to have this opportunity to stress the valuable assistance thus rendered.

You are all aware of that masterpiece of marine engineering the "Mulberry," more generally known in France under the title of "Port d'Arromanches." This harbour consisted mainly of pier heads connected to the coast by means of floating piers built up from steel bridge spans carried on steel or reinforced concrete pontoons.

It has not been possible to make use of the R.C. pontoons, but the steel pontoons have been used on the one hand for the manufacture of various other pontoons and, on the other hand, for the erection of a floating bridge which will be described in detail later on.

It should be remembered that the bridge units consist of two main lattice girders, connected by cross-girders which carry flooring units combining the function of stringers and decking.

The design adopted together with the systems of connecting links used, enabled the floating piers to ride a rough sea without any damage to their components. By means of telescopic bridge spans, provided at suitable intervals between the spans of standard length, the floating piers were moreover able to take up any variation in length of the decking caused by the wave action.

Both the standard and the telescopic spans were again subdivided in a light and reinforced type, the former designed to carry a 25-ton tank, the latter a 40-ton tank. The distance between the centres of the spherical bearings is 80 ft. 3 in. for the standard spans and varies from 71 ft. to 80 ft. for the telescopic spans.

This brief recapitulation of the main features of the Mulberry indicates the adaptability of this material for further use after salvage. Figure 31 shows the general appearance of a structure of special character across the Eure at Pont-de-l'Arche, for which Mulberry spans have been used.

Shortly after "Mulberry" had been taken to pieces 183 such components were assigned to us. Of these 114 were light standard spans, forty-one reinforced standard spans, twenty-one light telescopic spans and seven reinforced telescopic spans.

They had been dumped without having been taken to pieces, in heaps of two each, alongside the Canal from Caen to the Channel. These heaps were tightly packed together one next to the other and many of them were topped, moreover, with one of the steel pontoons.

Being quite unable at that time to find floating sheer legs of sufficient lifting powers to recover the spans, we used mast cranes and any other handy material.

The transport of this material proved a major problem ; as it was generally impossible to use either roads, rivers or the sea. For such transports we have used the railway after connecting the dump to the main line by means of a standard gauge siding approximately one mile long.

In order to save time, only such dismantling was carried out on the

dump as was considered essential on account of the working conditions at the site of re-erection, so that several 80 ft. long main girders fully assembled, have been travelling across France mounted on special trucks. Pushed forward as fast as possible the salvage progressed at a rate of nearly two and a half spans, including all ancillary operations, per working day.

The 183 spans under review allowed the erection of a large number of bridge structures some of which are of considerable overall length. From 1945 onwards, moreover, some Mulberry spans have been used for the erection of many temporary bridges at different locations in succession, and we are contemplating further such applications in accordance with the progress of permanent reconstructions.

At the present time Mulberry spans are used in twenty-five "departments" and the 183 components available are embodied in sixty different structures.

The following are specially worth mentioning :—

One bridge with six spans over the Ain.
One bridge with nine spans over the Allier.
Part of a bridge over the Seine at Pont-de-l'Arche where ten Mulberry spans are used for two parallel roadways.
One bridge over the north arm of the Seine at Rouen (five spans).
Two long bridges over the Loire (eight and ten spans) in the districts of Tours and Angers.
One bridge over the Moselle at Metz (twelve Mulberry spans for two parallel roadways).
Part of a bridge across the Rhine at New Brisach (nine spans).
One pontoon bridge across the Estuary of the Vilaine in Brittany (seven spans).

While the structures erected are generally of a semi-permanent character, those for roads of local importance are intended to be the final replacements.

The "Mulberry" bridges are designed for heavy vehicles with evenly distributed loads, as they are mostly fitted with self-laying tracks. In certain cases we have slightly strengthened the stringers or the decking.

Railings were provided and also footpaths, as you will notice in an illustration showing a bridge across the Moselle at Metz (Fig. 32).

The methods adopted for placing the spans into position have been many and of various character to meet the natural conditions obtaining at the crossing, such as the flow of the stream, and to fit in with the means at the disposal of the contractors ; the instances now to be discussed in greater detail will clearly show these varied methods.

The structures used as illustrations for this purpose are of a semi-permanent character.

Bridge at Chazey across the river Ain, consisting of six Mulberry spans.

The main girders which were assembled lying flat on the bank have been launched one by one using the method shown in Fig. 33. Drawn by tackle fitted to sheer legs mounted on trestles, the girder was held on the bank by another tackle and supported by a pulley block.

Fig. 34 shows a section of the finished structure.

The bridge of Pont-de-l'Arche, erected at the confluence of the Seine with the Eure, is an example of the composite solutions it was often necessary to adopt during the stage of emergency rebuilding ; this structure embodies both straight boom spans and Mulberry spans.

This bridge is provided with two parallel roadways and consists of ten Mulberry spans in all, eight of which are across the Seine and two over the Eure.

It was possible to use a floating sheer leg on the Seine for placing the main girders into position as shown on Fig. 35, on which it will be further noticed that the girder has been lengthened at both ends. Fig. 36 shows the completed structure.

The bridge at Chatel-de-Neuvre across the River Allier consists of nine Mulberry spans carried on semi-permanent reinforced concrete trestles (Fig. 37).

After being bolted together on the deck of a raft, each of the two main girders of a span was attached by its bearings to the up- and down-stream ends of cantilevers projecting from two gantries erected on each of the two trestles concerned, the main girders being held by pulley blocks carried from crabs running on the gantry cantilevers.

Each of the two main girders was lifted in succession, the fixed girder being used as a counterweight for the raising of the lifted girder. Following their raising to the height required, both girders were displaced laterally as far as their bearings.

Fig. 38 shows the completed structure.

In the case of existing piers the range of span available, because of the sliding of the telescopic spans, has often been of considerable assistance ; in certain exceptional cases the spans of standard length have been lengthened, as for a bridge across the Charente at Taillebourg, with the addition of a central cross-braced panel (Fig. 39).

In the Tours district the bridge of Port-Boulet across the Loire consists of eight Mulberry spans resting on the debris of the former masonry bridge. It was erected by launching each individual girder by means of an aerial ropeway. As shown on Fig. 40, cables guided the front of the girder, the rear end being carried on a trolley.

The cables were drawn over gantries erected on the piers, and at the extreme right will be noticed the balancing counterweight, the cables being anchored at the other end on the starting bank.

The bridge of Conflans-fin-d'Oise at the confluence of the Seine with the river Oise, consists of four Mulberry spans, which were fully assembled on the bank. A floating sheer leg of 50 tons lifted each span off the bank, carried it across the river and let it exactly down on to its bearings. Fig. 41 shows one of the stages of this erection ; only 12 minutes were necessary after this span had been lifted from the bank to let it down again on to its bearings.

Finally, mention should be made of the semi-permanent pontoon bridge in course of erection across the estuary of the Vilaine river at La Roche-Bernard. Fig. 42 shows the site and what remains of the former metal bridge, some 660 ft. long.

The size of the gap and the depth of the river bed made it quite impossible to consider erecting an emergency bridge carried on trestles.

Moreover, the variation in level due to tides is up to 22 ft. at spring tides and currents, which change direction with every tide, attain a speed of up to 7 knots.

The only means available to ensure a satisfactory solution of the problem was to use Mulberry spans. Fig. 43 illustrates the new bridge.

The centre portion has a length of 550 ft. and consists of seven spans, of which three are telescopic, carried by eight pontoons of eight units each. This centre portion is being erected in two halves on a slipway, each half is provided with its own pontoons and will be launched in a similar manner to that used for a ship (Fig. 44).

The anchorage necessary for this structure has proved of a particularly difficult execution. Steel cables connect the floating portion with heavy masses of concrete on both banks.

This paper, necessarily very brief, has illustrated some aspects of the reconstruction of the French road bridges. Its object will have been attained if it has conveyed a clear idea of the effort sustained by the engineers of the "Ponts et Chaussées" to meet the numerous difficulties arising from the lack of means at their disposal and of the ingenuity they had to display in this connexion.

The paper was followed by the presentation of two films on bridge reconstruction, produced by the Road Department of the French Ministry of Public Works.

Discussion

This opened with various expressions of appreciation and thanks, after which a number of technical points were raised and these are quoted below.

Mr. H. C. Adams, M.Inst.C.E., asked how, in the case of a curved beam or arch, when the prestressed steel followed the curvature of the member, the inward directed component of the steel stress was taken care of.

Dr. K. W. Mautner, M.I.Struct.E., replying to the question on behalf of M. E. Freyssinet, the inventor, and of M. Rumpler, said that this question practically only arises for structures for which the prestressing is carried out by means of non-bonded but mechanically anchored cables or bundles of H.T. wires as in the examples shown by the lecturer.

There is, however, a difference in principle compared with ordinary reinforced concrete. In the latter the inward directed component of the reinforcement of a curved or polygonal beam at the intrados is to be taken by stirrups or other means.

In a curved prestressed element, however, where the non-bonded cables or bundles are embedded in the concrete and stretched and anchored *after* maturing of the concrete the inward directed component does not exist as the tensile force of steel is in equilibrium with the internal compressive force in the concrete, the latter resulting, for two successive elements, in an outward directed component of the same magnitude as the inward directed one.

He said that he had answered this question already several times and referred to the discussion on Paper No. 5261, April and October, 1941, in the *Journal of the Institution of Civil Engineers* when it was explained why no danger of buckling occurs by the prestressing force itself, which is principally the same problem.

Applications of curved structures to annular cross sections (tunnels, tanks, etc.) is shown in his paper in *The Structural Engineer*, 1945, No. 3 (March, 1945). A sketch was made on the blackboard.

Mr. C. S. Chettoe, M.Inst.C.E. asked what proportion of bridges had been rebuilt in masonry and whether there had been any difficulty in France in getting masons to do the work. In England there was difficulty in getting masons to do stone work.

Mr. Peter Gerard, M.Soc.C.E. (France), replying on behalf of M. Rumpler, said that M. Rumpler could not give an accurate proportion of masonry bridges to reinforced concrete bridges, but in France they had experienced considerable difficulty in getting labour for the cutting of stone but they had concentrated immediately on masonry bridges because of the shortage of cement, steel and other materials. Also masonry did not require so much coal in the construction of bridges.

Mr. H. E. Aldington, M.Inst.C.E., M.Inst.T., said that he was sure that most of those present would be very interested to hear about the organization required for carrying out the very comprehensive schemes of reconstruction. They all realized and knew what a very heavy task had been laid on the French

engineers and it must necessarily have entailed a great deal of organization in the way of letting contracts and all that kind of thing. It would be of interest to many engineers to know how the contracts were let and how the work was organized. The whole thing was extraordinarily interesting, the manner in which the damaged bridges were repaired by the use of such a small amount of steel, the manner in which prestressed concrete had been used and the manner in which the bridging equipment designed by British engineers in connexion with "Mulberry" had been adapted and used by the logical engineers of France. Was all the work done by contract, was some done by direct labour and how were the tenders obtained for the work?

M. André Rumpler said that he would endeavour to answer the question in English. Before the war, generally speaking, all projects were prepared by the engineers of the Department of Ponts et Chaussées. After the projects were made in that Department they were sent to Paris where the Department had a central service—Service Central d'étude Technique. That service controlled the projects of the engineers and the Department sent a decision to the engineers and gave them powers of delegation to make a contract with the contractors. These contracts were generally tendered for. These methods, however, were not practical in the situation which prevailed after the war. After the war there were too many projects to be done at the same time and the Department had to ask for the help of all the civil engineers in France and also the help of the consulting engineers of the contractors. In cases where the reconstruction of a railway bridge and a road bridge was involved it seemed logical to give all the work to the same contractor. That was the beginning of the reconstruction. They had to use all the possibilities in as short a time as possible.

After three years he could not exactly say that things were better but they had the advantage of having more time in which to make a project and to contract out the work. They had a selected list of contractors and after making the project they asked the selected contractors to tender and the work was given to the contractor who offered the best price or the best conditions. In certain cases they asked the contractor to make the project. Those were cases in which the Department was not quite decided about what type of project to make—whether it should be reinforced concrete or prestressed concrete. In those cases the selection of the contractor was made not only on the price but on the type of project offered. When the chief engineer had contacted the contractors he was delegated power to contract the work without the intervention of the Ministry. He placed the order. It would be appreciated that they had been under the necessity of working very quickly and in order to do that they had had to take advantage of every opportunity and to use everything that it was possible to use. Once they had more time he hoped that they would go back to the method of asking any contractor who appeared to be able to carry out the project to do the work. The method of asking one contractor only was a very great convenience because to ask six or ten contractors in connexion with the same project was very expensive.

SAPPERS AT LAHORE

By " SENATOR "

"DURING the recent communal trouble, all commanders testify to the reliability, high morale, discipline and non-communal outlook of the engineer units engaged on I.D. duties in the Boundary Area." (Quoted from an article by the E.-in-C. India, in the March, 1948, *R.E. Journal*, on the " Reconstitution of the Army in India.")

" Sappers at Sialkot " (*R.E. Journal*, June, 1948) described the part played by units of 622 Corps Engineer Group during the disturbances which occurred in the Boundary Area of the Punjab after the granting of independence to India on 15th August, 1947. The story told in this article starts with a description of the author's trip down the road from 622 Corps Engineer Group in Sialkot to 474 Engineer Brigade in Lahore, about a month before the trouble really started.

The writer is not qualified to give a complete account of the last attempt of the Indian Army to fulfil its time honoured rôle of keeping the peace in India. Perhaps that task will be undertaken by someone else. Communal rioting focuses attention to a particular locality and problem. When it is continuous and violent, it allows an officer in charge of troops little time to sit back and absorb the general picture.

The part that the Sappers played in the Boundary Force was far from being a small one. A very heavy share of the task of protecting the minorities fell to them. Very many lives were saved through their efforts. More than anything else it was the relatively high number of junior British Officers in engineer units, when compared with the other arms, and the excellence of their quality, combined with the steadfastness of the men under their command, which earned them the praise and thanks of all who called upon them. In his last paragraph, the anonymous writer of " Sappers at Sialkot " pays a tribute to the Corps in India which can hardly be bettered.

Comparatively few incidents from the nightmare of July and August are related below. They are the only ones which I can still remember clearly. They do not arrange themselves chronologically in my memory, so it is not possible now to string them into a consecutive narrative. The reader's pardon is therefore asked for a disjointed account of what one Sapper officer of the Boundary Force experienced, with the plea that it may be of interest to some who know the places and people involved, or to others who wish to know more of what went on behind the screen of press comment during the days of horror which followed the granting of freedom in India.

THE LAST DAYS OF BRITISH RULE

As the winter of 1946–7 and the following spring wore on, it became apparent that the British were going, very soon, to " quit India." The patient and strenuous efforts of the Viceroy and British Government to hand over a united India failed to achieve their object. Finally the decision to partition India was announced. Slowly at first, and then with brutal suddenness came the realization that the division of the Indian Army was inevitable, and that the end of something to which so many British officers had devoted their life's service, was at hand.

Sadness at the loss of things as they had been was tempered, in the case of many, by relief at escape from the present. I remember one controversy that raged in the press for months. It was about the terms of compensation

for members of the Secretary of State's Services whose careers were suddenly to be terminated on the granting of Dominion Status to India. A special commission made some proposals which were duly published. One of the leading newspapers published a leading article which criticized the terms as "exorbitant." For months the ball banged to and fro, soldiers and civil servants fighting for their rights on one side, in the correspondence columns, and their only too numerous detractors, supported by the paper itself, striving to "do them down" on the other. A sad end to such a noble tradition of devoted service! Eventually the recommendations of the commission on compensation were implemented, despite the vulgar clamour of the press.

Another, more amusing controversy raged about the great Koh-i-Noor diamond. This, it was alleged, had been obtained by Queen Victoria in India by use of the most doubtful means. The return of the diamond was demanded, and the claim for its return refuted by correspondents to the daily papers, for some weeks. This hare was finally run to ground by a correspondent with a sense of humour. He said "The solution to the problem of the diamond is obvious, it must be partitioned," or words to that effect. (Partition of India had just been announced, and the word "partition" was, at the time, a slogan to some, anathema to others; at any rate a word on everybody's tongue.)

But "*Revenons à nos moutons.*"

If any of the three communities involved in the disturbances, about which I am writing, is accused of committing atrocities on another, the excuse is always given by the former that the acts were in retaliation for something done previously somewhere else by the latter against the former. Thus the Muslims in Lahore blamed the Sikhs in the East Punjab during the August rioting. The Sikhs drew attention to the massacre of their community by Muslims in the Rawalpindi area in the spring, who in turn recalled the massacre of Muslims in Bengal during the previous year, and so on. The minority community, unless it is a very tough one, always suffers.

Up to the date of partition the outbreaks of violence, although sometimes severe, had been sporadic. During the end of July and the first half of August, 1947, rioting spread, but remained subdued. Just before partition, news came through that trains in the East Punjab, moving west, were being stopped by Sikhs, and Muslim passengers killed. Towards the end of July I was sent to Lahore to take the place of an officer who had suddenly been ordered home.

Sikh Pensioners

Between Sialkot and Lahore there used to be quite considerable Sikh areas. For the benefit of the reader who did not follow events in India closely during the summer of 1947, it must be explained that these areas were eventually to be included in Pakistan. The Sikhs living there were a minority community amongst the Muslims. On the way to Lahore, I stopped at one of the Sikh villages, Ugoke by name, and had a meal with a pensioner of the Indian cavalry. He was a distinguished old man with a fine record. His father was a pensioner too, and at least half the menfolk of the family had served under the British as soldiers.

While the younger members of the party unsuccessfully tried to keep the flies off my food, and to keep me cool, (it was about 110 deg. in the shade at the time), the old men talked of their service in the Indian Army and of British officers they had known.

Although they did not know it then, all of them were shortly to become refugees and lose all their possessions. The old men seemed to sense what was in store for them, and spoke very bitterly: "The British have fostered us for a hundred years as their favoured child, we have served them faithfully. Now that they abandon us, what are we to do?" The speaker added after a slight pause, "It is true that we have made our mistakes too?"

It had been necessary in the early days of the war for a senior British officer, well versed in the ways and language of the Sikhs, to tour India addressing them wherever there were Sikh units. I had listened to one of his talks. The message he gave to the Sikhs was simple. He said that the British had indeed fostered them as a father fosters his favoured child, but if ever such a child "blackened his face" by ill deeds, he would be turned out of the house.

The older Sikhs of the party appeared to be a little uneasy about the younger generation of their community. Perhaps they felt that the face of the favoured child was already somewhat blackened.

As I left the village, my hosts held a subdued discussion, and then one of them produced a book. Gummed on to each page there were letters of commendation or thanks written by British civil or military officers who had partaken of their hospitality. I made what must be the last entry in the book.

LAHORE

Smoke was rising from the city of Lahore as we drove through. For some time Muslims and non-Muslims had been fighting a suppressed war within its walls. The latter used bomb and bullet and the former knife and firebrand. Already, according to estimates at the time, a quarter of the city had been destroyed. There were burnt-out houses at frequent intervals along the road which we used. The Mall alone retained a façade of prosperity. Although, in Lahore, the two communities were at first fairly equal numerically, the Muslims seemed to have gained the upper hand. A large part of the other communities had already departed.

Thanks to the great wisdom of our forefathers, cantonments in India were built at considerable distances from the native cities. The smoke from the burning city was almost out of sight of Lahore Cantonments, and so the wives and families of officers living there remained in happy ignorance of the appalling conditions prevalent outside.

There were more families in the plains than usual just then. For one reason British troops were in course of evacuating the Punjab, and their families, after coming down from the hills, were entraining at Lahore. For another, many officers, amongst whom I was numbered, were apprehensive of parting from their wives. The disruption of communications resulting from the disturbances might have made reunion extremely difficult. The lesser of two evils seemed to be that of keeping one's family down in the heat of the plains. It was a great mercy that, except for a few cases, our women and children were spared knowledge of the bestiality which surrounded them during those black months.

Engineer Troops in Lahore

The 474 Engineer Brigade contained mixed troops. There were units of differing classes and some units contained mixed classes. In all there were some 1,500 men available with arms for about 1,200. About 70 per cent were Muslims; there was one all Madrassi unit, one complete Sikh unit, and several Sikh and Hindu sub-units. The men were, generally speaking,

enlisted tradesmen, drawn largely from the cities, as opposed to the agricultural areas whence the regular Indian Army was almost entirely recruited. This was a fact which would have filled any officer, taking over command at such a juncture, with misgivings. The city dwellers were politically minded. Furthermore, all the units were Lahore Group units. Officers who served with the Indian Engineers during the war will know that although these units fulfilled a vital function, and in many cases distinguished themselves, their discipline and military training was not up to that of the units of the peace-time Corps of Sappers and Miners. The reader's attention is drawn to this so that he may the better appreciate the full measure of the achievement of the Sappers at Lahore.

The strain on the men's loyalty and discipline was very great. They were sometimes employed in protecting members of a community which elsewhere was engaged in turning their own families out of their homes, and sometimes in murdering them, man, woman and child. They were living in the same lines as men whose relatives might well be similarly engaged. Quite apart from this, they were members of communities at war with each other, inflamed by the strongest hatred of all, that inspired by religious fervour. In spite of this only once in my experience was the authority of a British officer questioned, or his order disobeyed. That instance is related later on in this article. Once, on seeing the blazing hatred in the faces of the Sikh sappers in our lines I became apprehensive of communal trouble amongst the men. I spoke to their Subedar and suggested moving the Sikhs to an isolated barrack. He was a regular V.C.O. of the Bengal Sappers and Miners, and his reply " No sahib, there will be nothing like that from us while you are here," set my mind at rest.

Very fortunately there were still about twenty junior British officers with the Brigade. Their performance cannot be too highly praised.

Officers

The officer situation during that hot weather was most depressing. It was impossible to plan ahead. In June, in one engineer formation, there were three officers in H.Q.R.E. and an average of three per unit. By September there would be two in H.Q. and possibly one per unit. By the end of the year there would be two diehards in H.Q.R.E. and most units would have no officer at all. Requests to higher command for replacements were met with the reply that none were available: that we would have to make shift with what we had: that units would have to run with one officer and V.C.Os. This, to put it mildly, was hardly encouraging.

War-time officers were finishing their days with the army, and returning to civil life. They can hardly be blamed for wanting to go as soon as they could. Regular officers found the India they had known vanishing day by day. Conditions were becoming more and more difficult for their families, the future more and more uncertain. One by one they slipped away. There was a feeling in the air that things were breaking up, which, indeed, they were.

I met a regular British officer in Lahore during the worst days of August. He had been almost renowned for his exploits on the North West Frontier in the old days. He had a brilliant career during World War II. To see him was a great relief. He would be a tower of strength in our troubles. I must have conveyed my feelings to him, for he said, I remember, " Oh, I decided that India had ' had it ' many years ago." He too was going to leave the country as soon as he could.

The complete abandonment of the Indian Army by British officers would probably have meant its disorganization and collapse on one side, at least,

of the new frontier between the Dominions. The men were the same ones who had served us so well in the past ; were we to leave them and have the foundation of their lives swept from under them ? How could we wantonly forfeit for ever their affection and esteem, and that of their descendants ?

Reverting to the officers of 474 Engineer Brigade. They were nearly all temporary officers, most of them due to return to civil life in a matter of weeks. One would have understood a tendency amongst them to let things slide until they left. In spite of the terrible heat and trying conditions in which they were required to work, one and all they more than pulled their weight.

Conferences

The Punjab Boundary Force was formed late in July. Its object was to provide a neutral force to maintain law and order in the disputed areas of the Punjab on both sides of the new boundary.

One afternoon in July the G.O.C. summoned all his officers to a conference at Lahore. Nationalization of the Indian Army had already gone so far that only about a third of the assembled officers were British. In a moving address he appealed to us to maintain the glorious traditions of the old Indian Army. This was to be its last task and we were to prove ourselves worthy of it.

At another conference of civil, police and army officers, held just before the fateful day, 15th August, the G.O.C. questioned a very senior police officer directly and before the assembled officers. In a general uprising of the people, could the police be relied upon to assist the army loyally and impartially ? (Already there had been many instances of dereliction of their duty by the police). When replying, the police officer could not resist recalling the happy times of efficient British administration in the early days of his service. Although things were not quite the same, he said, as when one constable of the Punjab Police could effectively ensure law and order in a crowd of 10,000, all the same, the Force could be relied upon if used in support of the army. I am thankful, for his sake that he did not see the police in action just after the partition of the country.

THE RÔLE OF THE ENGINEERS AT LAHORE

The troops of 474 Engineer Brigade were used almost entirely in an infantry rôle. Some engineer work was done, but the tasks were few. Here is a list of some of the activities of the Brigade, given in the reverse order of interest, the least interesting first, and the most interesting last. (They are described individually in the following paragraphs) :—

The maintenance of law and order in sectors of the Lahore part of the Boundary Area.
Engineer work.
Refugee evacuation convoys.
The Amritsar column.
Lahore Railway Station area.

I. D. Sectors

About eighty square miles of country, containing some sixty villages of from 100 to 2,000 inhabitants, and a corner of the outskirts of Lahore itself, was our share for the maintenance of law and order. This was subdivided by ourselves, and areas of 15 to 20 square miles containing perhaps twenty villages were allotted to individual units. Posts were established at the danger points in each area and intensive foot and M.T. patrolling carried out.

I visited one unit a few hours after it had been sent out to its sector. It was commanded by a very junior subaltern. He had made his arrangements very efficiently in a remarkably short space of time. His men were comfortably installed in the best house available, In his office his patrol map and programme were displayed in a businesslike way. His first two patrols were out. That night one of his platoons, led by himself, was fighting a small battle against a party of Muslims who attempted to loot an abandoned Sikh village. They killed a number of the raiders, some of whom were equipped with firearms, without themselves suffering casualties, and drove them off. They captured an assortment of weapons and some country-made bombs, which were proudly brought back to H.Q. This is only one example of an engagement in which Muslim sappers, led by a British officer, killed rioters of their own community. "Zindie," writer of an article in *Blackwood's* called "Four Days of Freedom," tells of a Sikh soldier shooting a fellow Sikh when ordered to by a Britisher, and thereby probably saving the lives of a helpless band of marooned travellers.

The first incident which really brought home to me what was happening everywhere, occurred during one of my visits to a Sapper I.D. sector. Although the papers daily reported riot and massacre, one did not fully take them in while in the peace and security of a well-cooled bungalow. We were still passing through the sector of responsibility of an infantry unit, when some villagers stopped my car on the road. The place was Baghwanpura village, quite close to Lahore. They said that a Sikh woman had just been murdered nearby. Sure enough, about a hundred yards away from the road, there was the body of a Sikh woman, cruelly stabbed. A short way from her lay a tin box which she had obviously been carrying. Standing over the body with a rifle was a Muslim constable of the Punjab Police. I asked the woman's husband, who was amongst the villagers, what had happened. He was a venerable old army pensioner. It appeared that he lived in a village about 400 yards distant. He pointed to it, and I referred to my map. It appeared to be called "Criminal Tribes Settlement," possibly through a mistake of the cartographer, but appropriately enough under the circumstances. There had originally been quite a number of Sikhs in the village, but a few had been murdered and the remainder, house by house, had left. At last there was only his family and one other left. Their Muslim neighbours cursed them for the acts of their co-religionists in the East Punjab and threatened revenge. At night the Sikhs shut themselves into one of their houses. They had realized, to their horror, that it was now too late. The British Raj was gone. There was no one who would save their property for them. All night long they talked it over. Fear strove with the love of their possessions. They decided to make a run for it. At Baghwanpura there were still a number of Sikhs and Hindus and it was 400 yards distant. At dawn they had picked up what they could carry and started to dash across the open space which separated them from their sanctuary. The hue and cry was raised immediately, and the Muslim villagers, armed with knives and spears, ran out after them. The pensioner's wife, who, in accordance with the custom of the country, was carrying the heaviest box, lagged behind. About half-way across she was overtaken, and many plunged their knives into her. The old Sikh who was standing by, told me that he was afraid to approach her body, as the policeman would have killed him too. The Hindus who had stopped my car said that the woman, as she lay dying, had cried for water, but that the policeman had refused approach to give her a drink. When I taxed the constable with this last accusation, he did not deny it, but replied, "She would certainly die, what was the use of giving her water?"

We could do nothing. The affair was "in the hands of the police." The old Sikh seemed to accept the loss of his wife with equanimity, but could not bear to think of losing the few pieces of jewellery which were on her body. I left my hindu escort facing the policeman across the corpse, and the Sikh, thus reassured, sitting within sight of the precious earrings, anklets and bangles.

Misunderstanding

Sometimes communal trouble started between small parties of troops. Usually it was caused by sheer misunderstanding. All Muslims and non-Muslims mistrusted each other, for which, by that time, they could hardly be blamed. A typical example of this misunderstanding occurred in one of the Sapper sectors. This particular sector contained Moghalpura Railway Station, a key point on the main line from Delhi to Lahore. As it happened the sector fell to the Sikh company, a platoon of which went to ensure the safety of the station. When this platoon took over the task from their predecessors, I was at Lahore Junction. One of the railway officials there said that he had just received a telephone message from Moghalpura to the effect that the station had been attacked by Sikh "Goonda" (bandits) who had beaten up the station staff and were now in possession of the railway buildings, shooting up all comers. Such reports were usually grossly exaggerated and there was an officer in charge of that sector in any case. I therefore told my informant that I had already sent troops to Moghalpura, and that they would certainly restore the situation when they arrived. Later that day, when I returned to cantonments, an officer of the Brigade told me that during the afternoon the Sikh Jemadar of the platoon at Moghalpura had come to him obviously very frightened. He had asked for reinforcements. The station was under heavy fire, and his platoon would not be able to hold it much longer. What had happened was this. The Moghalpura station staff had "gone to ground "as soon as they saw Sikhs approaching. They had sent their telephone message, and locked themselves up in an office. As a result, no trains could come through the station. Someone unknown had fired a shot as the Sikhs entered the station. The nervous Jemadar had ordered a volley to be fired in the direction from which it had come. This happened to be towards a mosque where Muslims were at prayer. Immediately word went round that Sikhs at Moghalpura station were shooting at Muslims in a mosque. The neighbouring I.D. posts then opened fire on the station, the troops in them being Muslims. Thus the battle had started. It was ended by two British officers who walked into it and explained the situation on both sides. Even this courageous effort was misconstrued, for I had received a report at the Junction station that two British officers had now joined the "goondas" and were directing their operations!

Fortunately there were no casualties in this fight.

Engineer Tasks

(*a*) *Demolitions and Fire Fighting*

The average Indian building is not of solid construction. When the next-door house has been burnt down, if it does not immediately fall down in sympathy, it clings precariously to its neighbour on the other side, a perpetual menace to passers-by, until it finally subsides into a pile of mud and rubble blocking the street below. Fire fighting, and rendering dangerous buildings safe, became the bane of sapper existence in Lahore. If one fire was extinguished with great expenditure of engineer effort, six others were started by firebrands carelessly tossed into open windows.

Calls for fire fighting and destroying dangerous buildings were answered as far as possible, but the task became so great, that it was far beyond our resources of men and equipment.

(b) Bomb Disposal

The investigation and disposal of some country-made bombs caused some excitement, but it fizzled out as quickly as the bombs did.

(c) Public Services

Sapper teams were provided to understudy essential technicians in the Municipal and Cantonment Services, but they were never required to take over.

(d) Raiding the City for Arms

One particlar type of operation was out of the normal run, and is perhaps worth describing. Troops and police would suddenly swoop down on a particular area of the city where the presence of armed " goondas " had been reported. The area would be completely surrounded by a Dannert concertina fence with lightning speed, (the engineer task). No one was allowed in or out. It would then be searched with a " fine tooth comb," some of the teeth being military and some police. Although the fence was in position in an astonishing space of time, the " bag " was disappointing. Some of the teeth in the comb were perhaps not as reliable as others.

The task was an interesting one for the Sapper officer in charge. He went down beforehand, in disguise, to the area concerned and mentally laid out his wire through the narrow streets. He had to memorize his layout very well. When the raid took place, his stores had to go to exactly the right points, and his fence was made without any further recce or marking out. Anyone who knows the narrow, winding and haphazard streets of an Indian city will realize that this was no mean feat.

Refugee Evacuation Convoys

At about midday one day in the first half of August a Muslim Jemadar Clerk came to me in great distress. He said that he had just heard from his family in Jullundur, where the Muslims were in minority. They had been ordered by the local civil officer to vacate their house by six o'clock that evening. If they were not out the house would be burned down over their heads. He begged for military transport to evacuate his family.

The man who brought him the message told me that all Muslims in Jullundur were receiving similar orders from the local officials. A notice was placed on the door of each house reserving it for some Hindu or Sikh, presumably someone who would be leaving the Pakistan side of the boundary as a refugee. This was the first indication I received of the thoroughness of the organization in the East Punjab, (a Sikh majority area), for ousting the Muslims. When the Muslims further west turned on the minorities in their midst, and drove them eastwards, it appeared to me to be a spontaneous movement of the people and I saw no evidence of organization or careful planning. Not so in the East Punjab But more of this anon.

I felt it was impossible to refuse the Jemadar's appeal, but it was certain that his case would only be one amongst many. In 474 Brigade there were Muslims from Amritsar, Gurdaspur, Jullundur, Ambala, Patiala and the other Sikh states whose families were in grave danger of annihilation, and who in all probability had already been driven from their homes. There were also Sikhs who lived to the west, in Gujranwala, Wazirabad, Sialkot, Daska and Kotli, to mention only a few places. In these the Sikh areas were already half destroyed. If we rescued one soldier's family, then help

would have to be given to all. There was nothing for it but to " take the bull by the horns " and try to evacuate all the threatened families in both directions.

A quick telephone call to the infantry brigade commander secured a reply that we could do what we wanted in the matter so long as we asked no one else for help. By four o'clock a number of those whose families lived in Jullundur had been collected and an evacuation convoy organized. The ever indispensable junior British officer was put in charge and enough transport provided for each man to bring in a family of ten members. Families had to be restricted in number. An Indian soldier's family might have anything up to sixty members, including grandparents, aunts, uncles and cousins on both sides. That particular convoy should have brought in 300 people. In fact, three days later no less than four times that number got out of the vehicles, with baggage. On the average a three-tonner had fifty in it and a twenty-tonner about a hundred. The Jemadar Clerk, who, incidentally had rescued his family (of about forty members) in the nick of time, felt it was incumbent upon him to explain away his breach of orders : " When our officer," he said " saw our weeping womenfolk and homeless children, his heart was filled with great pity and he refused no one place in the lorries." After this lorries were always filled literally to bursting point, and no questions were asked.

We were blessed with ample M.T. and so could run as many of these convoys as were needed from our own resources. After some weeks there were no more men left in the Brigade who still wished to look for their families. About 5,000 persons were finally evacuated. There were many though, who had not found their loved ones, and had given up the search.

The organization of military evacuation convoys at a higher level did not start until much later. The Jemadar Clerk's appeal must have resulted in the rescue of many families who would otherwise have been lost.

The Amritsar Party

One morning at a conference in the G.O.C's. office, I was asked how many men, in their own transport, could we produce in an emergency in addition to our other commitments. After a rapid mental calculation I gave the figure 400. As our commitments were constantly changing, an accurate assessment of our reserves at any moment was difficult. Afterwards doubts assailed me on the figure I had given, but some ugly incidents at the Railway Station drove the matter from my head.

In the evening when I returned to the lines, I found the convoy of my reply drawn up ready to move off. They were to go to Amritsar, eighteen miles east of Lahore. Four hours before, the S.O.R.E. II had been ordered by Divisional H.Q. to send the column off by 8 p.m. that evening. Although he had had no information of my hasty answer at the conference, somehow or other he had got the men ready under a few officers, and sent them off to time. They were from about six different units, many had just come off duty at the Railway Station or in the other sectors. Nearly all were Muslims. Accurate reports are not available of what they did at Amritsar. They were in Sikh territory, saving the lives of fellow Muslims, so no great strain was put on their impartiality. They kept order at Amritsar Railway Station, a very " hot spot," and fought several engagements in the country round, returning with a large bundle of spears and many Sikh swords. They were originally ordered out for twenty-four hours, but returned ten days later, many not having had a change of clothes in the meantime.

THE RAILWAY STATION

In Aid of the Civil Power

The most important task done by 474 Engineer Brigade at Lahore was the restoration of maintenance of law and order at Lahore Junction Station and the surrounding railway area. On about 14th July, our "Flying Squad" (consisting of one British officer, one V.C.O. and about twenty men) was ordered to go there immediately and "help the police to maintain law and order." They had been there a few hours when I received a report from Inf. Bde. H.Q. that the troops at the station had been firing a great deal, that the public was panic stricken, and that railway traffic was at a standstill. After arranging for more troops to be sent to help the "Flying Squad," I went down to see what was going on. The station was about eight miles from cantonments.

As we approached, the indications of mob violence increased. There were more and more dead lying in the streets. Outside the station yard the bodies of Hindus and Sikhs lay where they had fallen. Some were decapitated. There were more in the forecourt, and several in the booking hall. Near the booking office there was a Sikh lying in a pool of blood. His long hair was loose and his beard matted on his wounds. He was not quite dead and made feeble appealing gestures to us with his hands.

The young officer who had been in charge of the Sapper party met me in the entrance hall. He pointed to a group of police constables lolling on their rifles and said, "The one thing we really need here is to get rid of those people." He took me over the platforms. On one there were about thirty dead with more lying in the permanent way. Some platforms had been cleared of corpses but were still covered with blood. Wherever a train had come in during that afternoon there had been slaughter of the non-Muslims, particularly the Sikh passengers. He told me what had happened since his arrival.

Between noon and one o'clock a shot had been fired towards the station entrance from the direction of a Sikh Gurdwara (temple). The police fired back and later the temple was burnt to the ground and all inmates killed. This shooting was the signal for general slaughter. There seemed to be teams of four men working together armed with knives. Three of them pinioned their victim while the fourth stabbed him at will. If there was a lull the police fired a few shots into the crowd and started fresh panic, and hence the opportunity for more slaughter. From time to time trains came into the station and fed the crowds with unsuspecting members of the minor communities. The party of sappers was greatly outnumbered by the police, and could not effectively watch all the twelve odd platforms. It took the harrassed young officer some time to realize what part the police were playing. He looked for one of their officers, but during the four hours of rioting there was no officer to be found amongst them. He saw one constable raise his rifle and fire at an apparently harmless Hindu passenger. With one arm almost severed the man fell screaming to the ground. The policeman walked up to him and pumped rounds into him until he died. In defence of the police it must be said that all members of the minority communities were not necessarily harmless travellers. In one case a constable suddenly lifted his rifle and fired at a non-Muslim standing in a railway coach. There was a loud explosion which blew the non-Muslim to pieces and shattered the side of the compartment. The dead man had been carrying country-made bombs.

At length, went on my companion, he decided to ignore the police altogether. To have come into conflict with them would have been disastrous. He set about clearing the whole station of the public, and a senior officer of the railway, who had just arrived on the scene closed the line to trains for twenty-four hours, which prevented further crowds collecting. The sappers worked from the outermost platform towards the entrance, and by the time we arrived on the scene there only remained the troops, the police, a few of the sturdier railway officials and the dead passengers. I asked him whether his party fired much during the rioting. He replied that altogether they had fired one round.

He had some trouble with his V.C.O., but none with the rest of his party, all of whom were Muslims. It had happened like this. From the overhead footbridge he had seen a man in a bright mauve shirt stab a Sikh repeatedly and kill him. Calling to the V.C.O., who was standing behind him, to follow, he ran down to where the incident had occurred. A courageous railwayman, an Anglo-Indian, had followed him. He located the stabber at the back of a crowd of Muslims and told those around him to give him up. They laughed at him. The killer himself shouted "It is all right, Sahib, I am a Muslim." He turned to the V.C.O. and ordered him to go and arrest the man, while he himself stood with a Sten-gun. The V.C.O. demurred saying, "It is all right Sahib, he is a Muslim." Nor could he be persuaded to obey. Finally the Anglo-Indian bravely went into the mob and brought out the killer. He was duly handed over to the police. No doubt he was released as soon as his captors were out of sight.

Restoration of Order

In a few days a fair degree of law and order had been restored, and the station reopened to traffic. The steps taken were as follows :—

(*a*) The police were, as far as possible, kept clear from the platforms. This was not easy as there was a Railway Police Station inside the railway station yard. To compensate for their removal, they were given the task of keeping the forecourt clear of members of the public who were not bona fide travellers. This area was wired in, and by dint of constantly reminding the police of their task the area was kept fairly clear

(*b*) The booking hall was turned into a strong point containing our H.Q. It was completely under army control and all passengers had to pass through under the surveillance of sentries.

(*c*) All booking other than first and second class was discontinued and the third and inter-class entrances wired up.

(*d*) After some stabbing cases had occurred in the mob buying first and second-class tickets, they were forced into single file by making them approach the ticket offices between two closely placed wire fences. Although the stabbing cases had occurred under the very noses of our sentries, it had not been possible to find the culprits. When the crowd was thinned into a line, no more stabbing occurred at the booking office.

(*e*) Platforms were patrolled by day and night and strongly picketed when trains came in.

(*f*) The residential area around the station yard was picketed and patrolled. Thus the railway staff were able to move to and from their work. Several cases occurred when Muslim Sappers rescued Hindu railway officials from injury and death.

(*g*) Spot searches of the crowds in the station were carried out.

In all, the equivalent of about three infantry companies were required to carry out the tasks.

These measures were successful. From about 200 murders on the first day, the numbers fell to about thirty on the second, twelve on the third until there were only a few killed each day. Their value was proved when, at the request of the civil authorities, we started de-militarization. We stopped patrolling the platforms and abandoned some of the more prominent posts. Two days later the number of daily killed jumped to twelve and then to twenty. We expressed regret to the I.G. of Police and Deputy Commissioner for being unable to do as they wished and re-imposed full military measures. The murder graph fell immediately.

We learnt one or two lessons which may be useful to others elsewhere. We found that it was little use trying to catch would-be murderers before they had time to use their weapons. The troops available were too few, the killers too many, and the latter usually had the sympathy of a large part of the crowd. None the less a man contemplating murder will always plan his "get-away." Troops were therefore posted on the lines of retreat. The feeling of being hemmed in seemed to act as a powerful deterrent to the murderers. For example, there were two large shelters with two open sides normally used as waiting space by third-class passengers. In the early stages many were killed in these places. When they were wired in with a small gap as entrance, no more murders occurred in them. No troops were posted in them, and there were as many potential killers and victims as before. The simple expedient of wiring them in made them comparatively safe to all. This theory was further borne out when one of the outer platforms of the station was wired along its centre line. The object of this wire was to control refugees in trains passing through. All refugees seemed to wish to come to Lahore, and although told that Lahore was already overcrowded, and that their train was going further west, they swarmed on to the station in an uncontrollable flood as each train came through. It was hoped that the wire on the platform would keep them to their own train. Although we never succeeded in controlling the refugees, this wire further reduced the murders on other platforms. An Anglo-Indian official told me that previously stabbers had retired beyond it into the goods yard where they lurked among the wagons. This fence had restricted their line of retreat to the end of the station where they feared interception.

A very successful way of securing control over a riotous mob was found to be that of making it sit down. This may seem absurd, and is certainly not suggested in the manuals. Nor, in my experience, has it ever been discussed at internal defence exercises. Nevertheless the method was successfully used on more than one occasion around the station. After all, the active rioters invariably form a small part of the general public, the remainder being peaceful citizens, only too anxious to obey the forces of law and order. The bulk are dangerous only when frenzied by panic. The rioters use the crowd as cover from the troops and the latter are probably only visible to those on the extreme edge of the crowd. Nearly all orientals spend a large part of the day squatting on their "hunkers," and the assumption of that position comes naturally to them. They can be persuaded to sit on the ground more easily than a Westerner would be.

A study of the tactical effect of sitting a crowd down shows its efficacy as a means of bringing it under the control of a small body of troops.

(*a*) At first only those on the edges of the crowd hear the order, but when they have subsided those behind can see the troops and readily understand a hand signal to sit down.

(*b*) When the whole crowd is down, all can see the troops and the peace-loving citizens are reassured.

(*c*) Malefactors are immobilized. If anyone refuses to sit, or gets up after sitting down, he makes himself prominent and becomes a tangible object for the exercise of discipline, and hence an asset to the forces of law and order.

(*d*) The troops can see and hence command the mob which can be cleared by moving sections at a time.

(*e*) Troops at widely separated points can see, and hence communicate with each other.

Lastly concerning officers. The officer must keep personally aloof while disposing his men so as best to prevent loss of life and property. This is not easy for a young officer. When he sees murder committed, he probably feels like shooting the murderer. If he does this then two dead men are added to the score instead of one, and the parties concerned immediately assume that the British are taking one side or another. An officer's weapon must only be used in self defence and not to enforce law and order. There are several illustrations of this in the Boundary Area. In one case a young officer saw a man stabbed and himself fired at the assailant, fortunately missing him. However, he had fired at one of the majority community and there was an immediate outcry from officials and public alike. The fact that he had tried to punish a murderer did not affect the issue at all. There was an ugly period following this when the rôle of British officers as impartial workers in the cause of law and order had to be re-established.

Some British officers were killed while helping members of one community or another. However nobly they sacrificed their lives, it was a loss which the cause of humanity as a whole could ill afford.

Perhaps these riots, the greatest communal disturbances in the history of India, are the last in which British officers will be concerned, and these lessons, so dearly learnt, can be forgotten.

Searching the Public

In an effort to find the weapons carried by the killers, sudden searches of sections of the crowd were carried out. A small area was isolated by men carrying bamboo poles. Everyone in the area was searched by mine detectors. The mine detectors enabled the troops to avoid contact with the men who were being searched and so to avoid becoming verminous. Perhaps their greatest advantage was their moral effect. As a mine detector cannot distinguish between a cigarette case and a knife, this method was found to be little faster than ordinary hand searching. The number of weapons found was small, but the reputation we achieved as magicians compensated for this.

SOME EXPERIENCES

The reader may be able to get a picture of day to day occurrences in the Boundary Area from the following incidents which took place in and around the railway station.

There was a certain lady well known in Simla for her acting in the Amateur Dramatic Club. In appearance she was frail and very feminine. She left a train which arrived in Lahore from Simla during the worst part of the riots in the station. She saw the carnage on the platforms. I saw her standing in the booking hall looking as cool and unconcerned as ever she had on the stage, although she might have been in a charnel house. A good actress, or perhaps just a policeman's wife!

A breathless Hindu police constable came into our H.Q. He said he was one of a party of non-Muslim police who were trying to go by train to Delhi. They had been disarmed and were, at the time, huddled in the third-class waiting room with a hostile crowd threatening them. They were in fear of death. We escorted them to the booking hall, which was our only safe area, and hid them in a corner. One of them, a Sikh, remembered a piece of his baggage and went out into the forecourt to look for it. A Muslim policeman manning the forecourt seized the Sikh's puggaree and drew a knife on him. The crowd roared approval and seemed to be about to burst our outer wire. A small child, terror struck, threw himself on the triple Dannert fence guarding the booking hall and struggled through torn and bleeding. The Sikh had torn himself loose and ran into the hall with his long hair streaming behind him. For the moment I thought the howling mob would burst in after him. The Madrassis on guard levelled their rifles. We were lucky, the tumult died away to a murmur, and the pressure on the perimeter eased. An attack by the mob, helped by the Muslim police, on the hated Sikh constables would have swamped our stronghold and probably finished us all.

The problem now was how to get rid of our undesirable guests. Before long the mob might brave our fire and get at them. The answer was not long in coming. Most opportunely an officer of the Gurkhas walked into H.Q. and said that his battalion had come into the station two hours ago by special train which had pulled up over some long dead corpses. They were on their way to India, and were anxious to leave the station as soon as possible. Would I do something about it? I pointed to our cowering protégés and said would he do something about them. He said there was no room in his train. They had already given two coaches to refugee women and had three deaths and two births on their hands. However, the policemen could have the roofs of those coaches if they wished. I explained to a trembling Hindu sub-inspector that those roofs with 600 Gurkhas under them were probably, just then, the safest place available in the West Punjab for non-Muslims. They would, however, have to leave their baggage behind. With some difficulty they decided between their lives and their baggage, and twenty-four hours later made an undignified exit from Pakistan perched above the Gurkhas.

An Anglo-Indian railway official came up to me and said that there were six Hindu horse-box attendants in a room near the railway workshops who were afraid to come out. They were the last non-Muslims left there, the remainder had been killed or had made their get-away. Could we save them? I was called away to the telephone so made a quick note of his request. The official left the office. Afterwards I remembered the matter and considered what to do. Technically the workshops were outside our area. I summoned a Jemadar and told him to find the official and make sure exactly where the Hindus were. He was then to take a party of sappers and bring them in to safety. Other pressing questions then drove the matter from my head. Two days later I heard that the six fugitives had run for it, five had been killed and one badly wounded. I asked the Jemadar what he had done about them. He replied that he had never found the railway official.

Three officers were travelling west from Delhi by train. One was British, one Sikh and one Muslim. Near Amritsar the train was stopped by Sikhs. They went along it's length putting all Muslims to the sword. The Muslim

officer retired to the lavatory and locked himself in (each Indian first-class compartment has it's own lavatory). When the Sikhs reached the officer's coach the Englishman barred the door. He was pushed roughly back by the Sikhs who said "We don't want you, who else is in here?"

The Englishman answered, "Two British officers and a Sikh."

"Where is the other British officer?"

"In the lavatory."

A Sikh with a blood-smeared sword hammered on the lavatory door.

"Yes, what is it, old boy?" said a careless English voice from inside.

"Thik hai" said the Sikhs and continued on their way.

REFUGEES

The reader may already be tired of tales of massacre in India and of the immense flood of refugees which followed. Some descriptions have appeared in the press. I have as yet found none that does justice to what really occurred. The highest estimate of the dead, yet publicly announced, surely falls far short of the total.

All that has been described so far in this article took place in an area where non-Muslims were the minority community. Nothing that occurred there, I am convinced, equals in scope the horrors perpetrated on the Muslim minorities further east. This may be due to the fact that the number of Muslims who are in minorities amongst non-Muslims far exceeds the Hindus and Sikhs contained in minority communities. It was impossible to follow the regular sweep of the Sikhs down the Muslim areas of the Sutlej valley in the East Punjab without seeing that it was carried out as an organized and controlled operation. The participation of Government officials in the East Punjab in the task of ousting Muslims from their homes can be testified to by thousands. The Sikhs were well provided with firearms, whereas the Muslims fought with knife and spear.

Train after train passing westward through Ludhiana, Jullundur and Amritsar districts was held up and every Muslim passenger put to the sword. One train drew up in Lahore carrying a load of Muslim women who had been stripped naked by the Sikhs. Some came in dripping blood from the coaches. Sometimes there was a lull when trains came through untouched, and in the end the organization of Muslim military escorts for Muslim refugee trains put an end to this method of slaughter. Only too often the bodies of the dead from trains coming from the east were carried past our H.Q. They were just a few, the rest had been left by the wayside.

Long afterwards military trains carrying Pakistani troops of the old Indian Army passed through the East Punjab on their way to Pakistan. Some of the men told me of the rotting bodies of their co-religionists lying beside the line.

The number of refugees who moved in each direction after Partition was greater than the population of Ireland. The number of people who lost their homes for one reason or another was about equal to the population of Canada. Most of them moved on foot over a distance of 200 miles or more.

Occasionally one saw in the human stream a young man, wearing the uniform of the old Indian Army, bringing out his family. One, in particular I remember. He had two overloaded bullock carts followed by about fifteen people and some head of cattle. On the top of one of the carts lay an ancient patriarch. He was on his back and his eyes were closed. His long hooked nose accentuated by thinness and his snowy white beard hardly distinguished him from the pile of bags and bundles on which he lay. Behind the carts

streamed the family, some with more bundles, some carrying beds and some who had lifted the small children. The young soldier was driving the leading cart. He was dressed in spotless jungle green, perfectly pressed, and wore the tiger of the 26th Indian Division on his sleeve. He caught my eye and I saw his face light up for a moment. It was odd to think that only a few months ago he had been serving side by side with men for whom he now felt such bitter hatred.

RETURN TO SIALKOT

Late in September I returned by road to Sialkot. On the way we saw long foot convoys of refugees moving in both directions. Most of the towns and villages we passed through were partly destroyed, others utterly. The stench bore witness to the untended corpses lying in the ruins. At a village called Daska the brakes of our truck jammed as we passed through a refugee "camp." It was typical of most of the "camps" which were now dotted all over the Punjab. Twenty thousand people huddled together in the open without shelter or feeding or sanitary arrangements of any description. After a few days they were surrounded by a perimeter of human excreta and breathed foulness with every breath. On seeing an army vehicle many of the refugees approached and asked us when "the lorries" were coming to take them away. (We knew nothing of "the lorries" but were well aware of the desperate shortage of motor transport for evacuation purposes.) A Muslim officer who was with me, filled with pity, answered the inquirers. In the manner of most orientals he gave the answer deemed most acceptable to the questioner. The lorries would come very soon, he said.

An old Sikh made determined efforts to approach me but was held off by my escort. He was clutching a bulky document on which I could distinguish the Royal Coat of Arms. A grant of land, perhaps, for loyal and distinguished services to our King. He would ask why we British had allowed his award to be taken from him? What had he done to deserve it? I had no answer.

Our brakes repaired, we passed on through the camp. On the outskirts of Daska there were the bodies of murdered men in the fields lying where they had been struck down. Nature's scavenger, the vulture, was not there. Not only along the roads but deep into the country there were similar scenes. The vultures, for once in centuries, had more than enough.

At Ugoke, scene of my village breakfast two months before, all the villagers had fled to the roadside. I passed them, huddled together, my erstwhile host standing apart from the rest. He did not notice us go by. I had not the heart to speak to him in his discomfiture, and somehow felt ashamed. We sent lorries back from Sialkot later and evacuated him and his kin.

CONCLUSION

I feel that any more will weary the reader. The rioting further west was still to come, and there again the Sappers had a big part to play.

At a conference of all arms in Sialkot, the commander, not a Sapper himself, but having direct command of sapper companies, remarked during the course of a discussion, "My Sappers are the only people who get anything done." This is my final blast on the Sapper trumpet. If anyone prefers it to be blown by an officer of another arm, then I refer him to the final paragraph of "Sappers at Sialkot," published in the *R.E. Journal* of June, 1948.

WATER PURVEYORS TO THE KING

By LIEUT.-COLONEL J. J. D. GROVES, M.C., R.E.

"Watching the sappers working their sterilizing plant, the King asked to sample the water. He drank from a tankard, pure, clear water which only a few minutes before had been taken, brackish and muddy, from the river.

'It is very good,' the King said, adding with a smile, 'but you had better ring me up tomorrow to make sure that it was all right.'

The King then signed a certificate that the water was fit for human consumption."

(Extracted from *The Times* of 26th January, 1943).

THE 11th Armoured Division had passed its second birthday and we were to be honoured by a visit of the Sovereign. Unit commanders had been told that reception arrangements were to be of an informal character and that the King was to have an opportunity of seeing for himself the troops engaged in various aspects of training. The Divisional Engineers were to be concentrated in the grounds of Newton Hall, a few miles south of Cambridge, and field squadron commanders were given a free hand in the matter of detailed preparations.

Each troop of 13 Field Squadron was given a different subject of field engineering on which to base a small demonstration. No. 1 Troop was to produce a section engaged in mine-lifting ; No 2 Troop, a section launching a 40 ft. Bailey bridge ; and No. 3 Troop was to operate a brigade water point.

His Majesty was due to arrive at 11 o'clock and two hours earlier the Squadron Leader began his final round of the exhibits to ensure that the Royal progress would be marred by no avoidable mishap. The troops not actually engaged in the demonstration were drawn up in line, opposite to each of the three stands, so that every man of the squadron could have a good look at the King and see what he thought of their comrades' handiwork. Indeed the arrangements when looked upon were good—particularly the water point.

From a torpid little stream, a battery of No. 4 pumping sets were lifting water to a pair of brand new canvas sedimentation tanks, resplendent with their whitewashed edges. Two more highly burnished pumping sets lifted the slightly less murky water to a third tank perched on the top of a 15 ft. tubular scaffolding tower, where the sterilization process occurred. The distribution system was " as per plate " in the *R.E. Pocket-Book*. True, the taps of the water-bottle filling point shone with a surprising lustre, and the glistening paintwork of the water truck had been the subject of a Class II Trade Test, for which our painter and decorator had been subsequently up-graded. Even the section of roadway upon which the truck was parked had been meticulously laid in accordance with the statutes propounded by *Military Engineering*, Volume V.

Certainly everything looked all right—and with that reflection another possibility presented itself: what if His Majesty should want to sample it? Yes, he was renowned for the thoroughness of his inspections, so we simply could not take the risk.

Very well—but what was the King to drink out of? Here was a matter for rapid appreciation :—

Object

To produce a suitable vessel from which the King might sample our water supply.

Factors

1. The King may not be favourably impressed by our purification methods, in which case he will not want a drink at all.
2. The mess tumblers and beer-mugs are not quite up to Royal patronage —to produce one for this occasion might detract from squadron prestige.
3. There is sure to be something suitable in Cambridge—worth trying.
4. Time and space—one and a half hours before His Majesty is due. Cambridge market square only 5 miles away—and a jeep is available.
5. All roads in Divisional area are strictly closed to military traffic during period of Royal visit—so a trip to Cambridge may involve arrest by C.M.P. or possible collision with King's escort.

Courses Open

1. *To the King*
   (*a*) He will take it for granted when we tell him the water is fit to drink.
   (*b*) He will not.
2. *To us*
   (*a*) Exclude all drinking vessels from the demonstration area.
   (*b*) Produce a mess beer-mug.
   (*c*) Run the gauntlet to Cambridge.

Plan

Course 2 (*c*) was to be adopted.

The appreciation justified itself and the jeep returned in half an hour with a shiny new pewter tankard—quart size, with three handles and a glass bottom. It only remained to arrange a code-word upon which the Water Truck Corporal would spring into action and fill the tankard at the appropriate moment.

Indeed our arrangements had only just been completed before the Royal Party arrived. That curious thrill of pride and affection which the approach of our King invokes was very real to 13 Field Squadron as he walked across to meet us.

As he moved round the troop exhibits one realized how very well informed he was, and his questions regarding our state of training were not of a nature which could be satisfied by a repetition of mere platitudes.

From the mine-lifting demonstration he moved to the Bailey bridging exhibit, and then came the Brigade Water Point. He wanted to see exactly where the suction hose entered that dubious source of water. It was explained how the sedimentation and purification stages were performed—and finally he was assured of the purity of the water flowing at that moment into our beautiful water truck.

Photo 1.—H.M. The King samples the water.

Photo 2.—H.M. The King signs the certificate.

Water Purveyors To The King, 1,2

13th FIELD SQUADRON, R.E.

WATER SUPPLY

Certified :—

Effluent pit for
human consumption.

—Lieut R.E.

NEWTON HALL.
25 Jan. '43.

Now was the crisis!

"Do you mean to say that water is really fit to drink?" inquired His Majesty.

"Certainly, Sir," was the code word, and within five seconds Corporal Godliman had whipped out the tankard from its place of concealment, and filling it to the brim, he turned about with the tankard chest high, holding one handle in each hand, with the third directed towards the King.

"You never warned me about this," he remarked pleasantly to the G.O.C., who turned for enlightenment to the C.R.E., and at once the King entered into the spirit of the occasion.

"How am I to know it's fit to drink? Anyway, you are the one to try it first," said he as he accepted the centre handle and offered it to the Squadron Leader.

This was a contingency which had not been appreciated—and, with every eye of the squadron riveted to the pewter, excitement in the ranks grew red-hot.

"I am afraid Sir, that the troops will only be satisfied if the tankard is christened by you," the Squadron Leader parried.

Thereupon, His Majesty subjected the brimming quart to critical scrutiny and after a few more protests he took a substantial "pull" at it. "Well," he concluded, "it certainly tastes all right, but you had better ring me up in the morning!"

He then commanded the Squadron Leader to take a gulp before passing it to the Divisional Commander and C.R.E.

The party was in high good humour as the King completed his examination of the equipment, and there opposite the last brass bib-cock was a small refectory table upon which lay a fountain pen with a blank certificate beside it.

He read it carefully.

"I don't like the sound of this word 'effluent'!" he remarked as graciously he subscribed his name to the certificate, which is reproduced opposite.

And so ended a rather amusing and unusual interlude in the inspection of 11th Armoured Division by His Majesty the King.

As soon as the Royal party had left the grounds of Newton Hall the tankard was passed from hand to mouth down the ranks of the squadron until every officer and man had taken a sip of "Royal" water.

All of us felt that we knew the King now more personally than we had ever known him before. A few hours later the incident was briefly described by the B.B.C. in the six o'clock news broadcast. But it must have been recalled with no less delight by No. 3 Troop on many occasions during their subsequent journey from Normandy to Lubeck.

Indeed—"Purveyors of Water to the King!"

Note.—

The three faces of the tankard were later engraved as follows:—

(1) With a facsimile of the Royal Certificate.
(2) With the names of officers then serving in 13 Field Squadron.
(3) "His Majesty King George VI, having inspected the squadron at Newton Hall on 25th January, 1943, drank its health with this tankard."

OFFICER SELECTION

By COLONEL C. M. MACLACHLAN, O.B.E.

(This article is also being published in the *R.U.S.I. Journal.*)

FOREWORD

THIS article concerns the selection of officers for the National Service Army and *not* the Regular Army. The writer has had several years experience in the selection and training of potential officers, both as recruits and officer cadets. For just over a year he has been on a War Office Selection Board.

* * * * *

Quite recently a middle-aged business man said to me: "Your job of selecting officers must be a very difficult one." While I pondered this remark he added: "In all my experience of choosing subordinates I have been wrong so many times that I am sure I should not like to take on your job." Yet he was a successful business man and an employer of men in quite a big way. As I thought over his words, I considered my experience in the past four years and decided to write about it. Is officer selection a difficult trade? Let us examine it critically and see. In doing so I propose to cover three events:—

(*a*) The recruit training period in an Army Basic Training Unit (A.B.T.U.)
(*b*) The War Office Selection Board period (W.O.S.B.)
(*c*) Officer Cadet School period (O.C.S.)

In the first two events it is the selectors who count; in the third the users. If an excursion into the past may be permitted, the A.B.T.U. might be likened to a Remount Depot where likely young horses are gathered together. In the W.O.S.B. are the Remount Officers, who view the horses critically and reject those unsuitable for training. The O.C.S. is the Cavalry Regiment, where the young horses are sent and from which those that do not come up to the required standard are returned to remounts.

A DESCRIPTION OF THE SELECTION MACHINE

Before considering the working of the selection machine let us give a brief description of it. After the soldier has been allocated to an arm of the service and posted to an A.B.T.U., he undergoes certain intelligence tests and is interviewed by a Personnel Selection Officer (P.S.O.). If by intelligence and education he comes up to a prescribed standard, the P.S.O. asks him if he would like to be considered as a Potential Officer. If he agrees, he is next considered by the Regimental Selection Board. If he gets over this hurdle he continues training until it is time for the Remount Officers to have a look at him. He is sent to a W.O.S.B., where he is vetted and put through his paces. If found suitable, he returns to his A.B.T.U. and awaits posting to an O.C.S. Just as the young remount was given some degree of training in the depot, so the young Potential Officer is given some in the A.B.T.U., but to carry the simile further, they both arrive in the Cavalry Regiment, or O.C.S., as comparatively raw articles. The young remount may not catch the eye at first, but if he has the right make and shape and quality he should be persevered with. A cavalry regiment which returned to remounts an undue proportion of horses as untrainable, rightly got a bad name. The same applies, or should apply, to the O.C.S.

That then is the machine. It is a complicated one and works at high pressure. Soldiers enter the Army every fortnight and the successful candidate is commissioned about six months after entry. It is clear that the machine requires tending with care.

Assessment of the Potential Officer

Let us now take a look at the young recruit in the A.B.T.U. There are two sides of his make-up we want to be clear about :—

(*a*) Hereditary qualities.
(*b*) Form.

When considering the merits of a race-horse it is usual to discuss both pedigree and form. Neither by itself is convincing. Take the first three horses in this year's Derby, for instance. Before the race the Newmarket watchers were well satisfied with the form of the winner, Nimbus, but his breeding indicated lack of staying power. On the other hand, Swallow Tail, who was third, was considered a genuine stayer by breeding ; yet his form prior to the race was considered below Derby standard. Amour Drake, who was second, was thought to be a stayer by breeding, but there were doubts about his speed ; yet towards the end of the race he was gaining on the other two with every stride. He finished a head in front of Swallow Tail and a head behind Nimbus, though he was a neck in front of the winner a stride past the winning post.

There was a good deal of conflicting evidence between pedigree and form ; yet all three horses finished the race successfully. So it is with potential officers. It is unwise to rely entirely on heredity or entirely on form. The two must be considered together and balanced.

Human beings possess hereditary qualities both physical and mental. I propose to discuss only the latter under three headings :—

(*a*) Intelligence.
(*b*) Brains.
(*c*) Character.

It is just as well to be clear about the meaning of " intelligence." Quite simply it may be called mother wit. The psychologists, however, define it as : " The ability to reason rapidly from known facts to a correct conclusion." It is thus a measurable commodity and can be brought to light by tests. It should not be confused with brightness or ready wit, which, for example, one associates with Anona Winn and Jack Train in " Twenty Questions." People can be seemingly bright without necessarily being intelligent, and vice versa. (I must add hastily that I am not questioning the intelligence of the well-known B.B.C. personalities referred to !) It is, however, rash to try and assess intelligence without resort to intelligence tests. That is why they form a definite part of selection procedure.

People are born with a certain potential, as regards brains, but brain power cannot be measured in the same way as intelligence. We can, however, examine the use to which people put their brains. Their educational achievements, together with the ages at which achieved, can be noted. For instance, a boy who gets a higher school certificate at the age of 17½ has, either got better brains, or made more use of them, than the boy who just scrapes through the school certificate by the time he is 18½.

It is interesting to compare intelligence and educational standards. Low intelligence does not automatically mean a low educational standard. For instance, it is noticeable that a low intelligence rating sometimes goes with a pronounced weakness in mathematics. Nevertheless, many intellectual

people with a high educational standard are weak in this subject without being unduly handicapped. Some people with a high intelligence rating have a poor standard of education. From the potential officer's point of view, a low standard in both is a great handicap, unless he has compensating qualities of another sort. In practice, a satisfactory combination results from a reasonable standard in both intelligence and education.

As regards character, it is undoubtedly true that heredity plays some part. We all know the expressions: "Like father, like son" and "A chip of the old block." The C.O. of an A.B.T.U. once wrote concerning one of his potential officers: "He's all right. I knew his father, who was in the regiment and his grandfather was in it before that." The selectors found themselves in agreement with this verdict, but, and this is important, not without examining form as well. Some sons are not always like father. Some are better and some not so good.

In considering form I propose to divide it up as follows:—

(*a*) Home and School background.
(*b*) Observed form.

Life at home and at school both affect a boy's background. The things that matter are stability, happiness, and social and educational development. During my own experience I have been struck by the devasting effects which a broken or unhappy home may have on a boy, and at the other end of the scale, by the stabilizing effects produced by a happy home. The same, perhaps to a lesser extent, applies to school life. A boy who is not happy at school loses a good deal of the zest of life. From the social point of view the things that matter are, I think, manners, poise and interest in people. These can all be acquired in a good home and easily eluded in a bad one. On the educational side both the narrow aspect of acquiring knowledge and the broader one of developing character have to be considered. It is the latter which is so important for the potential officer and which requires to be done both in the home and at school, if good results are to follow. A boy who is taught at home to adopt a responsible attitude to life and encouraged to stand on his own feet, has a great advantage over the one who is over-sheltered and has everything done for him. While at school, leadership experience, whether as a prefect, captain of a game or sport, N.C.O. or under-officer in the cadet force, scout leader, etc., is of great value to a potential officer, provided he learns from his experience. By no means all do. Leaving aside the value of leadership experience, however, the importance of a general education, until school certificate has been acquired, and of staying at school as long as possible, cannot be overstressed. The experience, from the broad point of view, gained between the ages of 17 and 19, can be invaluable. It is between these ages that a boy has the best opportunities to broaden his outlook and learn the meaning of responsibility. Moreover, he is able to develop his character both in the field of sport and from the various social activities in which he becomes involved during the vital period when he changes from being a boy to becoming a man. The boy who leaves school early may be more sophisticated than the one who stays on, but he is usually more limited in outlook.

So far we have considered past form. Now let us go over to "Newmarket" and consider present form. At the A.B.T.U. the Potential Officer can be observed over a period of weeks; at the W.O.S.B. over a period of two and a half days only. I do not propose to make out a list of officer qualities to be looked for. It would not only take too long, but I doubt if much would be gained from it. In the W.O.S.B. the fields for investigation are laid down by

the War Office. In the A.B.T.U., quite rightly, nothing is laid down. It is left to the common sense and experience of the officers concerned. The success with which selectors ply their trade depends a great deal on the ability with which they form their opinions from the evidence given them by their eyes and ears. I propose to consider this under the following headings :—

(*a*) First impressions.
(*b*) Physical appearance.
(*c*) The candidate's expressed views.
(*d*) Behaviour.

We often hear people say : " I like to make up my mind quickly about a person " or " First impressions are usually right." By a quick summing up of character, the really experienced selector may be right more often than he is wrong, but it is in the cases of error where this attitude is so dangerous. In assessing potential officers there is no need to make a hasty judgment and the wise selector always bides his time.

Some people at first sight look very odd. " I can't see that chap as an officer ; he just does not look the part " is a remark often made. He may not look the part but does he perform the part ? That is what matters. It is equally wrong to think : " Yes, that's a nice-looking chap. He looks as if he were good at games. He's bound to be all right." He may turn out to be all right, but the good selector does not make up his mind until he has seen him in action.

An experienced selector does not allow himself to be prejudiced, if a candidate expresses views contrary to his own. He is entitled to his own views and if he is not afraid to voice them, this is an asset rather than a weakness. The " Yes man " who simply trots out things designed to please, may not offend the ear, but he is not showing great strength of character. It is always wise to remember that if a boy has surprising views which may not seem altogether desirable, they can probably be modified by further training ! The selector's golden rule here is never to allow himself to " rise " when he finds himself in disagreement with a candidate—difficult advice perhaps, but from bitter experience the right one !

Now I come to behaviour, and this I think is the most interesting feature in the art of assessment.

It is probably true to say that when candidates are being tested as potential officers, the majority behave naturally and can be seen in their true colours : unfortunately, however, experience shows that this is not always the case. Conciously or unconciously, some candidates put up a screen, as it were, to hide their true worth. In some cases this makes them appear better than they really are and in other cases the reverse. Here are a few examples :—

(*a*) Some candidates appear on the surface to be extremely confident. They talk at great length and shove themselves to the fore at every opportunity. Very often the reason for this is that they carry everything in the shop window and have no reserve or depth of character to fall back on. They display their limited qualities with all their might, so as to cause a good first impression. The good selector sees through this and watches the candidate carefully to find out if he really has got more in him than meets the eye. In many cases he is unable to maintain his initial efforts and tails off as time goes on.

(*b*) Some candidates appear at first sight to be provocative, awkward in manner or self-opinionated. Very often this is due to nervousness, which they try to cover up by a sort of display. This is a good example of the danger of first impressions and the experienced selector waits for the candidate to settle down before forming his opinions about his attitude.

(*c*) Other nervous boys appear bored or uninterested at first sight. This may be another screen to cover up their feelings.

(*d*) Many quiet and reserved boys remain in the background and do not display their worth unless forced to do so. Some may have nothing to display and their screen of "masterly inactivity" tends to hide the fact. In other cases their behaviour is bound up with a state of mind which tells them that it is "not done" to shove themselves forward. Some genuinely do not want to prejudice the chances of their comrades. Whatever the cause, the good selector recognizes this type of candidate and bides his time, before making up his mind about him. Very often, unlike the "shop window" type, he improves steadily on acquaintance, even if he is a bad salesman.

Within the W.O.S.B. the examples given are of common occurrence and success in dealing with them lies, first of all in their early recognition and, thereafter, by careful observation and the exercise of patience and restraint.

The Selection Machine in Action

We have had a look at the recruit. We have had something to say about the selectors. It is time to study the selection machine in action.

In the A.B.T.U. the initial selection of potential officers is done by the Personnel Selection Officer. He goes almost entirely on the standard of education and intelligence. Boys with school certificate or higher are nearly all accepted. It is not always possible for the P.S.O. at this early stage, to discriminate between those who have officer quality and those who have not. Consequently, a good many of the latter, in some cases rather to their surprise, are selected as potential officers. Boys who are not up to the educational and intelligence standards laid down, may still be selected if accepted by the Regimental Selection Board. This may come to pass by personal application or individual spotting by squadron (or equivalent) commanders. It is the job of the Regimental Selection Board to weed out those who are obviously unsuitable. This, however, is not a very easy task, because a boy, once selected by the P.S.O., may not take kindly to being turned down by the Regimental Selection Board. I believe the only satisfactory principle to go on here is to advise him in his own interests to withdraw, until he gains further experience. If he will not accept this advice he should be sent to the W.O.S.B. As one C.O. told me: "The arbitrary striking off of his name by a C.O. is bad psychology." Another pointed out that the boy's parents are much more satisfied with an adverse decision made by a W.O.S.B. than by a C.O. Their state of mind can be summed up in these words: "How can the C.O., who commands 1,500 men, know our son well enough to decide that he is not suitable for a commission? If, however, he appears before a board of officers under War Office supervision and undergoes searching tests, then we feel the decision is a fair one." If this principle is followed, the task of the Regimental Selection Board is really simplified and the candidates themselves, to say nothing of their parents, feel much happier.

The composition and working of the Regimental Selection Board is of interest. The most obvious method is for it to consist of a president and two members appointed by the C.O. Candidates appear before the Board for interview and are accepted or otherwise as potential officers. This method is not entirely satisfactory. It is liable to be an ordeal for the candidate, particularly if he is nervous or diffident. Moreover, an interview without corroborative evidence of form, may give the wrong impression of the boy's merits. A better method is for the Board to consist of the C.O. as president, and two officers as members who make it their business to get to know the

candidate as well as possible. These should be the candidate's squadron and troop commanders (or equivalent). The troop commander sees most of the boy's performance in training and reports on him to the squadron commander. The latter keeps a separate dossier for each candidate, giving details of his home and school background and past achievements. He gets to know him, both by observation and interview, and reports on him to the C.O. The latter can then interview the boy with some knowledge of his background and form, and is in a position to advise him whether to try for a W.O.S.B. or not. The advantages of this method are :—

(*a*) The members of the Board work together as a team and base their opinions on a reasonable knowledge of the candidate.

(*b*) The C.O. (as president) has plenty of evidence to go on, before he advises the candidate, whether to try for a W.O.S.B. or not.

It is the A.B.T.U's. duty to send reports to the W.O.S.B. about candidates before their arrival there. It is not necessary in *all* cases for the officers, who write these reports, to decide in their own minds whether a particular boy will or will not make an officer. What they should try and find out are the strong and weak points in his character and leadership ability. If they happen to discover odd behaviour traits, it is a good thing to mention them in their reports. These reports can be of invaluable assistance to the W.O.S.B. An A.B.T.U. selector should never make the mistake of thinking his report will not be examined in the W.O.S.B. Unit reports are read out to the members of the Board and the weight attached to them depends on the care with which they have been compiled. A report of unqualified eulogy for the candidate, which in the W.O.S.B. is seen to be undeserved, naturally carries little weight. The critical report giving strong *and* weak points, always carries weight.

In the W.O.S.B., as I have already mentioned, the candidate is observed over a period of two and a half days. During the first day he fills up certain forms and does intelligence tests. The former provide useful information about his home and school background, interests, hobbies and previous experience. During the second and third days the candidate is observed by a team of two officers and by the President (Colonel). The team consists of a field officer, known as the Team Leader, and a captain, known as the P.S.O. The Team Leader sees something of the candidate's performance in tests, indoors and out, but his most important contribution is in interview. From this he is able to form an opinion about the candidate as regards background, past achievements and character. The P.S.O. supervises all tests, indoors and out, and he assesses the candidate's worth from actual performance. The President sees something of the candidate in action and gives him a short interview. On the third day, on completion of tests, the final board conference takes place, presided over by the President. The Team Leader and P.S.O. each give him their views. The unit report is also carefully considered. The board members then give their recommendations regarding the candidate's suitability or otherwise for O.C.S. training, and grading. The President makes the final decision. The main advantages claimed for this system are :—

(*a*) That it is a good team event.

(*b*) That the candidate's background and form are carefully considered and balanced before a final decision is made.

On the whole the system works satisfactorily. It cannot be foolproof. What system could be ? I think most people would agree that the obviously good and the obviously weak candidates can be recognized. Difficulty sometimes arises in assessing those who are between these extremes. Here I

want to try and clear up some misconceptions. W.O.S.B. tests are not conducted like exams. Candidates are not marked. Nor is it a question of passing or failing individual tests. Candidates may appear negative in specific tests, but if somewhere they come out clearly in their true colours, there is no reason why they should not pass. On the other hand a candidate may, on the surface, do well in individual tests, and yet not pass. For instance, one who is limited as regards education and breadth of outlook, may be good on outdoor tests, where his practical experience stands him in good stead: indoors, however, his limitations become plain to the eye. He may be better suited as an N.C.O. than an officer. A very shy candidate may give negative evidence of his worth in group tests, but may come out in very different colours in the two interviews. I once saw a candidate whose performance in group tests, including his own command test was distinctly weak. Even in interview he was very shy, but he had quality, brains and intelligence. He was passed. His form at the Officer Cadet School was followed up. He was at first a very doubtful quantity and was relegated. He ended up with an above average grading. Several of my friends have said to me: "I would never have passed a W.O.S.B., if they had been going when I joined the Army." Before I was posted to a W.O.S.B. I thought the same. Is this remark due to polite modesty or to an inherent distrust of W.O.S.B. methods? I suspect it is both. The doubts are, I think, due to the idea that a candidate must thrust himself to the front to pass W.O.S.B. The selectors themselves often get rather bored with this type of candidate. If they pass him, it is not because of this behaviour, but rather in spite of it. If he has the necessary ability, he can be likened to Nimbus who took the lead from the start in the Derby and just stayed there. How many of his backers thought he would? How many candidates who take the load from the start, stay there? Like race horses, a great many do not.

I have already indicated the lines on which selectors approach the assessment of candidates. By the end of their time in the W.O.S.B. most of them get sorted out into passes or fails, but sometimes one or two remain as doubtful. In some cases their unit reports also indicate doubt. They do not show up clearly anywhere, either in tests or interviews. The selectors, of course, watch them with particular care. If in the end a recommendation for training at the O.C.S. cannot be made for them, this does not mean they are debarred from having another try at W.O.S.B. The President may discuss their performance with them after the testing is over and give them advice. If their C.Os. consider them worthy of another try, they may recommend this to the War Office. About 50 per cent of "second shotters" are successful, which is an encouraging fact.

Although a candidate, before he comes to a W.O.S.B., can be helped greatly by tactful encouragement, I am very averse to the idea that he should be coached with the object of passing, in the same way that a crammer coaches him to pass an exam. If before his appearance at the W.O.S.B., he is given tests, more or less identical with those he gets there, this may give him a superficial advantage, but it cannot alter his character. It is this which matters far more than his ability in "knowing all the answers." Everyone, experienced in selection methods, agrees that a candidate does himself more justice, by coming to the W.O.S.B. with an open mind, than by trying to mug up the answers beforehand. Certainly a great many candidates to whom I have spoken, agree with this view. Apart from this, the time available for their training in the A.B.T.U., before they are posted to the Officer Cadet School is all too brief. Nothing is more short-sighted than

to use up some of this valuable time in coaching them for W.O.S.B. On the other hand, training designed to develop confidence, initiative and a responsible attitude towards National Service is invaluable.

The last part of the machine to discuss is the Officer Cadet School. From the selection point of view there is one aspect only—the rejection of unsuitable officer cadets. The case against a high rate of rejection is strong. Officer cadets tend to become nervous and strained and cease behaving naturally. Mutual confidence between officers and cadets is destroyed. Mutual confidence between the O.C.S. and the W.O.S.B. is also strained. If the W.O.S.B. system were perfect the question of rejection would not arise except on medical or disciplinary grounds. Unfortunately this is not the case. The selection machine is, however, improving greatly as its users learn by experience and the rejection rate is in consequence, decreasing. Apart from this there are a few principles worth discussing.

The key man is the Squadron (or Company) Commander. He gets to know his cadets as intimately as a good house-master gets to know his boys in a school. To some extent he has to depend on reports from junior officers who instruct and observe his cadets. As in the A.B.T.U. they work in together with him. Like the A.B.T.U. Squadron Commander, he keeps a separate dossier for each cadet, giving particulars about him. It is a wise principle that an officer cadet should never be put up for rejection without being relegated at least once. Many officer cadets take time to settle down. Early impressions about them may be unfavourable, but also may be incorrect. The experienced Squadron Commander always takes his time to form opinions about his cadets. If, after he has tried his utmost, he finds himself defeated by a cadet, he is entitled to take him to the Commandant for consideration for rejection and return to his unit.

Conclusion

The various parts of the selection machine have been described. The W.O.S.B. is its hub, because without it the other main parts, the A.B.T.U. and the O.C.S., would not work efficiently. Before the late war, cavalry regiments did not get their horses direct from dealers. This was the province of the remount officers, who sorted out the good from the bad. In the same way the O.C.S. does not get its officer cadets direct from Units. The W.O.S.B. sorts out the good from the bad. The officers who tend the machine must have confidence in one another. In particular the W.O.S.B. and the A.B.T.U. should be interdependent. Here the key to success lies in good liaison.

There is still widespread misconception amongst officers in the Army about officer selection. Many mistrust the methods employed. If this article helps to allay their suspicions, it will have achieved one of its objects. Modern selection methods have so far been in operation only for a few years, but I believe they have come to stay. They are by no means infallible, and recognition of this fact by officers in selection is important, because it makes them approach their duties with greater sincerity and thought. In this way improvements are effected and the degree of error lessened.

To the question : " Is officer selection a difficult trade ? " I would answer : " It is like any other trade. It must be learned carefully." Under these circumstances there is no reason why the trade should be particularly difficult.

Success in the assessment of the potential officer's character and ability depends on the zeal and efficiency of individual selectors, the extent to which prejudice is eliminated, and the degree to which the selectors work as a team.

COMPRESSED AIR WORKINGS

By MAJOR R. M. POWER, R.E.

WORKING in compressed air is frequently employed to enable construction work to be carried out below water level, or where the soil is fine or water bearing, and it is impossible to control the ingress of water by sheet piling, coffer dams, etc. By balancing the air pressure in a working chamber against the water pressure outside, the inward flow of water can be arrested, and work carried on in the dry. A pressure of 51 lb. per sq. in. is equivalent to a head of 110 ft. of water. Typical examples of such work are the driving of tunnels under rivers, and the sinking of caissons for foundations of bridges and quays.

Such compressed air workings introduce their own special problems, such as, locks to allow the passage of men and material to and from the working chamber, special plant to supply the compressed air, and precautions against compressed air illness, called diver's palsy, caisson disease or more commonly the " bends." Fig. 1 illustrates a typical example of a caisson being sunk under compressed air.

PERMISSIBLE PRESSURES

Pressures up to 40 lb. per sq. in. have been commonly worked, and a Committee, convened in 1936 to study compressed air workings, recommended that men could work in pressures in excess of 50 lb., though such high pressures considerably reduce the economical working, as explained later in this article. Human " guinea pigs " have been compressed up to 135 lb. and in one case to 205 lb., though in the latter case the " guinea pig " failed to survive due to carelessness during decompression. At such high pressures the air becomes heavy and sticky. It offers considerable resistance to movement, and requires quite an effort to force a cardboard through the air, while a paper fan will be broken. Such extreme pressures induce drowsiness akin to drunkenness with a marked falling off in mental capacity, and may even cause nervous fits ranging from epilepsy to uncontrollable hiccups.

Up to 20 lb. per sq. in. there is little risk in compression on a fit man, apart from some pain in the ears during the compressing stage, due to the pressure not being balanced on both sides of the eardrum. By swallowing, or holding the nose and blowing, the Eustachian tubes from the eardrum to the throat are opened—a slight click can be felt as they open—so balancing the pressure on both sides of the eardrum, and the discomfort disappears immediately. Persons with colds will experience pains in the forehead due to blocked sinuses. In extreme cases above 20 lb., these complaints may lead to burst eardrums and bleeding noses, but generally there is no limit to the speed of compression apart from a person's ability to adjust the pressure in his ears.

Once in the compressed air there is little difference from working at normal pressures, though a man will find that he is capable of greater physical exertion before his breathing is affected, on account of the extra oxygen per volume of air. Temperature and humidity depend on open air conditions, but generally will tend to be hotter and more humid than outside. At higher pressures it is impossible to whistle, cigarettes burn quicker and a match requires more effort to blow out or extinguish.

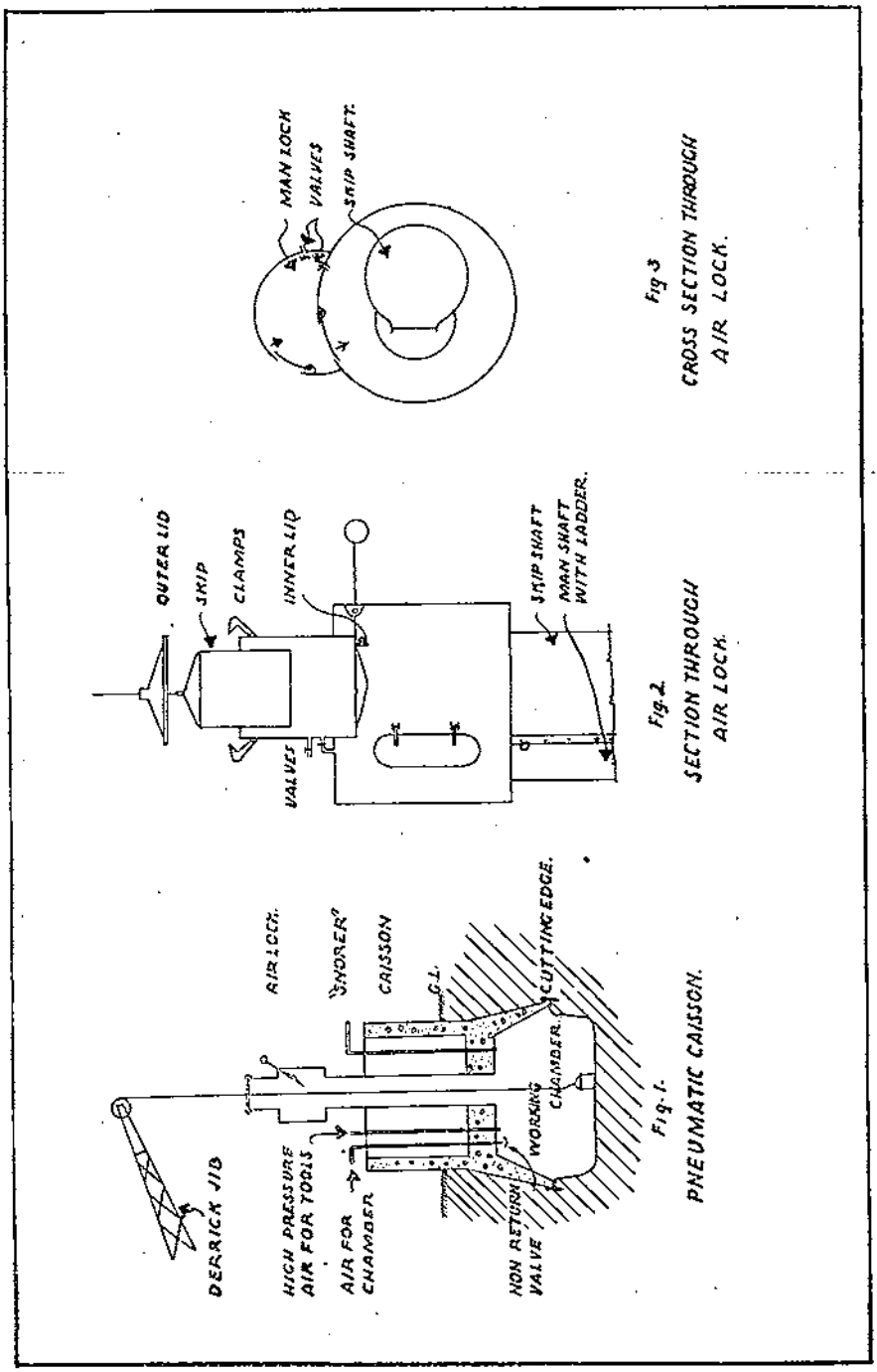


Fig. 1.
PNEUMATIC CAISSON.

Fig. 2.
SECTION THROUGH AIR LOCK.

Fig. 3
CROSS SECTION THROUGH AIR LOCK.

Compressed Air Illness

During the time that a man is under compression, his body gradually absorbs more air in the same manner as gases are dissolved in liquids. The real danger in compressed air working occurs on decompression, when the drop in pressure liberates this additional air from his system. Whilst the oxygen in the air is used up in the body, the nitrogen remains to form bubbles and impede the circulation of blood, and unless this free nitrogen is given time during decompression to disperse, this accumulation of nitrogen bubbles will produce the complaint called compressed air illness, also called " bends " because its most prevalent symptom is pain in the joints of the body. The whole cycle can be compared to a soda water bottle, which dissolves gas under pressure, but on release of the pressure this gas effervesces at a rate depending on how the cork is removed.

In its mildest form, the " bends " produces a prickling sensation on the skin, then dizziness and pains in the joints similar to rheumatism, whilst at its worst it can produce paralysis by blocking the paths to muscles, and even death. The effects are proportionate to the pressure and the duration of exposure. For any pressure there is a time limit up to which the liability to symptoms increases, and after which, the body will have absorbed the maximum amount of nitrogen. The higher the pressure the quicker this condition of saturation is reached. It has also been found that on decompression no bubbles are formed till the absolute pressure has been reduced by half ; the absolute pressure being the sum of the gauge and atmospheric pressures. Acting on this, it is usual to restrict the hours of work at high pressures and to take decompression in two stages according to the following table :—

Gauge Pressure	Maximum hours of work	Pressure reduced in 2 min. to	Final reduction to atmosphere after		
			6 hr. work.	2 hr.	½ hr.
22–24 lb.	8 hr.	4 lb.	10 min.	—	—
28–30 lb.	6 hr.	7 lb.	45 min.	21 min.	—
			4 hr. work		
38–40 lb.	4 hr.	12 lb.	96 min.	60 min.	12 min.

Under 20-lb. pressure no special precautions are recommended, apart from slow decompression, usually obtained by a small size valve on the manlocks. Exercise during decompression also helps to dispel bubbles.

The " bends " effects may appear 15–30 minutes after leaving the lock, but rarely later than 6 hours. The Committee, previously referred to, recommended that men should be kept on the site before being dismissed, 40 minutes for pressures from 25–40 lb. and 1 hour above 40 lb. pressure. Hence for an 8-hour shift at 40-lb. pressure over a quarter of the time is spent in leaving the working chamber, during which time men have to be paid at the higher rate for sinkers, some 25 per cent above outside rates.

The only satisfactory cure for the " bends " is rapid recompression to about half the absolute pressure, followed by very slow decompression. For pressures above 25 lb., a medical lock should be provided for " bends " cases, fitted with beds, independent access for medical attendants, and heating to overcome the cooling effect of expanding air during decompression.

The " bends " also effects sea divers in exactly the same manner, unless wearing special deep diving pressurised suits. During the last war experiments were carried out to discover a means whereby divers could ascend rapidly from great depths, without the necessity for raising them slowly by stages, or of having to put them in decompression locks at the surface. By mixing air with a non-poisonous gas, insoluble in blood, it was found possible to provide a sufficient quantity of oxygen at the increased air pressure, yet at the same time to keep down the amount of nitrogen dissolved in the blood to normal. Amongst gases used were hydrogen and helium. In this way it was claimed that the safe time for ascent was reduced in one case from 47 to 7 minutes, and in an emergency to even 1 minute.

Access to Workings

Access to the working chamber is provided through locks, separate locks for men and for materials. The material lock may be the side door type in which the material is pulled in and out on a tramway, or the pot lid type in which it is hoisted in buckets by a crane (see Figs. 2 and 3). In both types doors are provided for sealing the lock, and there are taps or valves connecting the lock to the outside air and to the inside compressed air. The lock is operated by two locksmen, one inside and the other outside, the inside man working the inside door and the outside man the outer door and valves. In the pot lid type, the outer door is a lid carried on the crane rope and sliding through a gland packing. When the bucket is inside, the lid is clamped down and there is an inter-locking device to prevent the clamps being undone before the lock valve has been opened to the air. Door type locks are foolproof, both doors being made to open inwards, hence they cannot both be opened at the same time.

For low pressure working the man-locks are usually operated by the men themselves, but for high pressure working a locksman should control the lock pressure from outside, to ensure that decompression is taken at the correct speed. The " bends " like malaria, is a case of prevention being better than the cure, but again, like malaria, this point is not always appreciated, and on the human principle that it never happens to me, men will pass through the locks too quickly, repeatedly reducing the time until they get the " bends." One attack is sufficient to cure the impatient.

Compressor Plant

The size of compressor is governed by the required pressure and a supply of 600 cu. ft. of free air per man per hour for ventilation. The amount of air actually used will depend on the degree of " blowing " by air escaping around the cutting edge, and also on the frequency of opening of the locks. " Blowing " keeps the pressure down near to the hydrostatic minimum and also assists working conditions by ensuring good ventilation. The pressure in the working chamber therefore is largely self-regulating, depending on the " blowing," and the compressor unloader is set to cut out at a pressure above the estimated head, with a safety valve on the chamber to limit the maximum. When fully sealed, as during concreting of foundations, there is no escape of air and consequently the chamber becomes hot and humid and the pressure must be regulated by the safety valve.

Compressed air tools are worked from separate high pressure compressors, with a considerable drop in efficiency depending on the caisson pressure. During an emergency, or when the plant has to be shut down for adjustment, the working chamber pressure can be maintained by opening all tool connections, provided of course that the high pressure compressor is of sufficient

capacity to replace any escaping air. The air supply to the chamber is through a non-return valve which will retain some pressure in the event of the supply failing.

Caisson Sinking

The resistance of a caisson to sinking depends on :—

(*a*) Resistance of the ground to the cutting edge—varies according to the design.
(*b*) Lift due to the air pressure in the working chamber—in a 20-ft. by 50-ft. chamber at 16 lb. per sq. in. this amounts to 1,000 tons.
(*c*) Friction of the sides of the caisson—reduced with splayed sides which also reduce tendency to scaling.

These resistances are overcome by weighing down the caisson either by building up on top, or by adding a temporary kentledge. The caisson can also be dropped by temporarily reducing the pressure in the chamber, known as " blowing down."

To keep the chamber dry the pressure should be kept in excess of the required hydrostatic head, which will also have the advantage of permitting excavation to be carried down below the cutting edge and so enable some control to be exercised on the rate of sinking, and in keeping the caisson level and in its right position. If excessive water does accumulate, it can be pumped out from a sump by simply connecting a pipe to the outside and allowing the inside pressure to force out the water. This pipe is called a " snorer."

In some soils it is possible to dispense with air pressure when the caisson has reached an impervious strata, and thereafter to rely on the sealing effects of the sides to keep the water out. On the other hand it may be necessary to increase the pressure to overcome the artesian effects of subterranean streams.

Tunnel Driving

The problems here are very similar to caisson sinking, except that some means must be provided for forcing the cutting edge forwards, usually by jacking, and also for building up the tunnel shaft behind the cutting edge.

Diving Bell

This is perhaps the earliest known use of compressed air working. It is in effect a portable caisson used for underwater work. It consists of a bottomless chamber into which air is pumped, and so keeps the water level below the bottom edge. The whole contrivance is lowered into the water, either with the men already in it, or in some cases the men enter through locks. It is used a good deal in marine engineering for laying anchorages, stone quays, etc.

" THE EXPRESS "

ANONYMOUS

THIS is a story of a week's ski-ing from a hut in the Tirol. A hut, as yet not too well known and so frequented only by a few. There are no great thrills such as may be obtained by those younger and more daring in knocking five seconds off their record down the Kandahar run, but a certain amount of hard work which resulted in a wonderful week in beautiful surroundings for a very small cost. The writer is fortunate enough to have among his friends a young man who is a very fine skier and instructor, educated, and like so many of those from the Tirol a delightful companion. I will call him Andreas, though that is not his real name.

On a sunny afternoon in early April, I reached his home in a small house in the grounds of a fifteenth century Schloss near Innsbruck. Set in a lovely wooded park on a hillside overlooking the town, where a waterfall and a trout-stream rush down to the valley of the Inn, it seemed a perfect rendezvous. Andreas allowed me a short time to see the old pictures and other treasures of the Schloss and to wander through the lovely grounds where the spring flowers, yellow primula, crocus and purple anemones were just out, set against the background of the snow covered mountains which rise 2,000 metres above the town. We then had to get down to serious and organized packing before starting at 7 o'clock the next morning for a journey by tram and bus which would finish with a 2-hour climb carrying our skis and all that we needed for a week. Food was available at the hut, but I had brought a week's army rations for one and a bottle of whisky. Other things I had packed in two echelons, A the essentials, and B the desirable, in case we could persuade or hire a local to carry up B. This Andreas said was most unlikely, and also intimated that it wasn't done. I therefore discarded B *en bloc* and turned my attention to the pruning of A. Andreas, who naturally was in far better training than I, reckoned he could and would take about 60 lb. plus his skis, and I felt that 30 lb. was about my maximum. A change of clothes is essential and in April it may vary from really hot to bitterly cold if it decides to snow between 2,000 and 3,000 metres. Gloves, windjacket, sun cream, and dark glasses, slippers, cigarettes, a towel, but my electric torch must go. Army potatoes and bread were left, as those could be got at the hut, and some of the less inspiring forms of tinned food were also discarded. Reasonable loads having been achieved, much care in the packing of rucksacks was needed. The body requires insulation from sharp corners of tins and if all the heavy items are at the bottom of the rucksack there is a great drag on the shoulders. Butter, tea, sugar, cooking fat and the like incline to seep into each other. A few small screw-top aluminium tins save all this confusion.

Soon after 7 a.m. on Sunday morning we started for the tram to Innsbruck and made the bus there with nearly half an hour to spare. A wise precaution on Andreas' part, as all Innsbruck was off to ski and we were in time to get a seat. Only one other skier alighted at our village, all the others going on further to Kühtai, a better-known and more developed ski-centre. After just over two hours we reached the hut, at 1,650 metres, sun on the snow and sweat on the brow. " Not bad considering," said Andreas, which presumably meant me. I was allowed a good meal, and was then taken out for two hours practice on the local slopes as I had not skied for three months. At the end of this time I suggested to Andreas that as I had also climbed 800 metres with an enormous rucksack in the morning and if I was to perform tomorrow in earnest, it was enough. He agreed adding, " I thought you would be much worse the first day."

The hut was a comfortable small house, though the sanitation might have proved too conspicuous in the summer. It had a fair size dining-room, which we did not use except for ping-pong, a kitchen with dining-table in a bay window, and three or four matratzenlager. These are rooms with rows of mattresses on the floor, each mattress with its own blankets and pillow. The biggest could sleep about twenty, Andreas and I shared a smaller one with room for four. There was always hot water in the kitchen and on sunny mornings we washed in the stream 100 yds. away. There was also a home-made Sauna (Finnish equivalent of a Turkish bath) just outside. Rudi the Hüttenwirt (mine host), was a delightful man of about forty, educated and possessing the perfect manners which the Tirolese have. He was a fine skier and extremely fast uphill. Mädi, who did everything, was a quick-witted girl, an expert cook and a very shrewd card player. There were no other visitors except Andreas' brother and his wife who joined us for two days. Normally we got up about 6.30 a.m. ; the first awake " took out " the window. In our room the window did not open, you just took it out ; as it froze at night it was " in " while we were asleep. Shaving and washing took place in the kitchen while Mädi cooked the breakfast, though Andreas usually made the porridge and I made the tea, which no Austrian can. I was considered a bit fussy to shave every day up in the mountains, and I nearly had to give up by the end owing to lack of face from sun, wind and snow. Between 8.0 and 8.30 we would start off on our day's climb carrying a light lunch, a few extra woollies and some boiled sweets. These are ideal for a long climb in hot sun, and I got a good mark for bringing them. On long distances it is essential to climb at one's own pace and at as steady a rhythm as possible, as this is far less tiring. Our daily climbs were usually 3 to 4 hours and our longest on the last day between 6 and 7 hours ; Andreas' rate suited me perfectly. One day we went with Rudi, who led at his own terrific speed which I found most exhausting. He took us up nearly 1,000 metres in barely 2½ hours, which is well over the standard 1,000 ft. an hour, particularly as there was a mile-long flat stretch in the middle. An ominous mist started at the top so we had to descend at once, shortly to run into the sun again and then a short but very steep climb to a large hut more like a hotel. After lunch another 300 metres climb, and then a long run down home. Rudi left us at top speed as he had to go down to the village below our hut to shop, including more beer. May I never have to climb 800 metres carrying one or two dozen beer. Andreas and I stopped halfway down to sunbathe and also because the last 500 ft. or so, which was the finish of most of our runs, was my *bête noire*. A narrow steep slope running for about half a mile between woods, it always had too much or too little snow. It was covered with bumps whose surface was icy in the shade and soft in the sun. Various rocks and tree-stumps littered the fairway. There is a similar but much shorter stretch near the end of the Kandahar, before the bridge. It needed incessant quick turns of infinite variety and resource ; I never mastered it properly, even though I was made to practice there all one afternoon when we had a slight thaw. It was doubtless very good for the soul, particularly as I usually carried my skis up it. As I was telling Andreas firmly that this was the last time I was going down that day, he said very quietly, " Yes, and now you have put your ski on the wrong feet."

Most of our ski-runs started down from between the 2,500 and 3,000-metre level, giving us 4,000 ft. or more descent. In April the snow was often perfect powder snow, but it changes very quickly according to the sun, wind and so on. Generally speaking if it is a real hot day you should start down before noon, or it gets soft and there is danger from avalanches, and sunbathe at the

end. If not so hot, there is no need to hurry. Sunbathing needs care and the much advertised Nivea cream is not as good as it makes out.

I will not describe our various runs at any length, except the last day when we skied back to Innsbruck. They were all in the high mountains mostly in the sun, where you get that wonderful feeling of exhilaration in a world of your own, knowing remotely that there are a few poor creatures living and moving below the snow line. Occasionally the mist would come down or a sudden April snow-shower on top of the Rotenkogel (9,000 ft.), would drive us from shirt sleeves to two pullovers and a windjacket.

The evenings were not late. A huge and excellent dinner and then ping pong or simple Austrian games. The ping-pong table was small and had a hazard at head-height either end, one an oil lamp and the other a very brooding Auerhahn (capercailzie). Schnappser was a card game rather like nap, at which Mädi was the expert. This took some mastering as it was played with the German cards whose four suits are Hearts, Leaf, Shell and Acorn, and apparently two kinds of knaves called Ober and Unter. As both these two were exactly like each other and very similar to the King, I was apt to let down my side in an emergency. The game was played in a mixture of German and Tirolean dialect, so some of the finer points escaped me. There was also another simple but entertaining game on the Blind Man's Buff principle. The "he" was blindfolded and equipped with two large wooden spoons. The victim was clasped between the spoons and only by stroking, slapping, prodding, etc., with these was "he" allowed to identify his choice. As it was permitted to change places and clothes after a failure, a good deal of not so quiet fun took place.

There was no "Bad im Hause," but as I mentioned there was the Sauna. This, taken about once a week, at the end of 8 or 9 hours climbing and ski-ing is a magnificent institution. It consisted of a room with a tiered platform at one end and an enclosed stove stoked from without at the other, also a dressing-room. The stove is lit 2 or 3 hours beforehand and when the room has become a hot dry hell you go in. In this room are two or three buckets of water and on top of the stove a number of large stones. When everyone is thoroughly warmed up one of the buckets of water is thrown over the stones, clouds of steam are produced and a hot wet hell. If you have not previously perspired freely, you do now. After 5 minutes or so of this you beat each other with a small birch twig broom to stimulate the circulation, though you feel nothing but heat. The hardiest, meanwhile, have gone up to the top tier which is the hottest. This completes Phase 1 which takes about quarter of an hour. All then rush quickly outside, roll in the snow, and rub each other with it. In our Sauna, or outside it, we did not roll in the snow, except Andreas did once, as a slight excess of rolling might have landed half-way down the valley. We contented ourselves with throwing buckets of icy water over each other. The devil in charge then leads the way back to hell and Phases 1 and 2 are repeated to taste, in our case twice. The result leaves none of the languor of a Turkish bath, but a wonderful feeling of well-being and relaxation of tired muscles.

On the last day Andreas considered I was sufficiently toughened to make the "Express" run from the hut back to Innsbruck. The food and whisky having been consumed our rucksacks were only about half the weight of the first day. The "Express" consists of three separate climbs, each 2,000 ft. or more, and three wonderful descents, the total downhill running is about 10,000 ft. and the overall journey about 30 kilometres. It was a glorious morning when we started just before 8 a.m. and the first 2,000 ft. odd was not too steep to the Schaflager Kogel (2,410 metre) and I did not notice my rucksack. Just

as we reached the top it clouded over and got cold so that by the time we had taken off our skins we did not want to loiter. The first part of the run down was steep and rather misty, but the last 1,500 ft. the snow was glorious and the sun came out. At the Alm, at the bottom, we had a short rest and then started in blazing sun up to the Haidl (2,300 metre), which Andreas said was a steep climb but not so long. The first third was steep but straightforward, the next portion seemed to be on snowladen bushes suspended on snow and the last 700 or 800 ft. so rocky that the skis had to be carried. The weather decided to have a small sharp snow blizzard at this juncture, and it was bitterly cold and misty at the summit. No rest for the weary and by now I was acutely aware of my rucksack. The start of the 800-metre descent to the next alm was steep, visibility bad and the snow deep ; what helped me down more than anything else was two headers into deep snow by Andreas, who is a superb skier. A further trial awaited us at the bottom, the small Gasthaus was closed, it was still bitterly cold and we were now due for food and a rest, which had to be taken in a large and draughty cow-byre. Andreas, who though quite a young man, has always the gift of saying or doing at the psychological moment the one thing that matters. He realised that I was so cold and tired that our food, bread, sardines, chocolate, milk and sugar, which on a sunny day was quite inviting, was at that moment quite repellent to me. He prepared it all and on getting no response said very softly, " Look, I have made it all ready and you won't eat, please, you must." With another 2,000-ft. climb ahead, I realized this most acutely. I then remembered we had a small bag of raisins on which I started, I was then able to face a sardine and from there to a cupful of milk pretty solid with sugar. How right these dieticians are that sugar is energy ; I made the climb without undue fatigue and the sun came out again. I could even admire the wonderful scenery on the saddle under the great serrated crags like Dolomites. How I enjoyed the 3,000-ft. run down in lovely snow, finishing on the F.I.S. standard run down to Mutters. We took off our skis for a mile walk where the snow finished and Andreas said we must run or we should miss the last bus to Innsbruck, but if we did it was only an hour's walk home. Here I became insubordinate ; I would not run and I would not walk home, we would have a good meal in Mutters and Andreas would phone Innsbruck for a car even if it cost one hundred schillings. We missed the bus by 5 minutes, but we found a delightful Gasthaus where grandpa was telling bed-time stories to his little grandson and white-haired grandma had the finely carved face of an aristocrat. Ice-cold beer, soup, real pork sausages, eggs, spinach and red wine from Süd-Tirol and we rolled home in an antiquated limousine which *did* cost 80 schillings (£2).

Andreas and Rudi tell me I shall receive the " Express " Bronze Badge, which at my age, and not too good weather conditions means 7–8 hours, but I think they have juggled the figures in my favour. I am told the record for this 30-kilometre journey, involving nearly 7,000 ft. of climbing, is under 3 hours ; Rudi's supergold Badge is just over 3 hours. Even a Tirolean mountaineer needs fine weather, no rucksack and intensive training to do this. Tours long and short like this are I think the best of all and within easy reach of the skill and purse of anyone, though you must of course have an experienced guide with you. Excluding my insubordination in Mutters the week for the two cost about £6.

Andreas tells me that there is a Super-Express run which I might tackle next year. This includes about 10,000 ft. of climbing and is over 40 kilometres, so that I had better have two weeks' training and we must start about 3 a.m. I have not yet decided whether this journey is really necessary.

BLITZ FIRE FIGHTING AND SAPPER DEMOLITIONS

By Brigadier W. H. G. Costelloe (Retd.)

IN January, 1942, twelve months after the events here recorded, the writer was called to Portsmouth to discuss the question of demolitions during a blitz with Commander Sir Aylmer Firebrace, the then National Fire Services Chief, who, as ex-Commandant of the London Fire Brigade, had had the sad experience of seeing so much of the City destroyed by fire.

Commander Firebrace was then engaged in studying the experiences of many blitzed towns, and the new Southern Region Fire Service had called his attention to the way in which the spread of major fires had, in five examples at Portsmouth, been successfully checked by explosives.

After close study on the ground and examination of witnesses Commander Firebrace said that he was satisfied that, in these cases, the creation of fire lanes by demolitions with explosives had provided the only possible answer and had undoubtedly saved much property from the flames. He went on to say that the circumstances in Portsmouth were so similar to parts of the City of London which had been gutted, that he regretted very much decisions which had been made (either pre-war or in the early days of World War II) to the effect that the creation of fire lanes by Sappers using explosives was unsound and that this proposal had been abandoned.

Now, in 1949, the writer hears that many Sappers support the prevailing opinion that the making of fire lanes by means of demolitions is far too expensive in time, explosives and man power and thus the operation is not "on." Well, they may be right, nevertheless the job was done five times by 2 C.W. Group, R.E., on the nights of 10th–11th and 11th–12th January, 1941, in Portsmouth and this was the way of it.

Nos. 63 and 64 Chemical Warfare Coys., R.E., which had been recently formed, were hurriedly given bridge demolition tasks in Hampshire and Dorsetshire when the collapse of France became imminent. As time went on the newly formed 2 C.W. Gp., R.E., with 64, 65, 66 and 74th Coys., became the field engineer resources of the Portsmouth and Southampton areas, largely engaged on "defences" and with specific strategical and tactical demolition tasks in addition to sector manning in the event of invasion. Chemical Warfare and other Engineer and Military training went on as best it could.

Civil Defence was very much a civil affair and, although note was taken from time to time of the potential help which the Army and Navy could give, the Services were left in no doubt that blitzes would be handled effectively by the civil power, who would ask for any help they might need. Nothing in the way of combined training or exercises or even detailed discussion was held but we, foreseeing that our help would be needed in a hurry made such engineer, police and fire brigade contacts as we thought prudent and gave some thought to possible demands both by Portsmouth and Southampton.

As far as emergency blitz demolitions were concerned the plan of H.Q. 2 C.W. Gp. was to rely on using those troops, transport and resources which were always ready for action whenever there was an alert, as part of the general military defensive arrangements.

Noisy nights were the rule. Usually most of the noise was our own cannonading of circling aircraft or of those on passage. But on 10th January, it soon became clear that an extraordinary attack was being made. H.E. and incendiaries soon started many major fires and fire brigades from many towns began to pass by our H.Q. at Cosham Manor.

About 2200 hrs. the Area H.Q. passed on an appeal for R.E. demolition parties, which had been made by the A.R.P. Controller. Four detachments of 65 Coy., each commanded by a 2nd lieutenant, were ordered from Fort Purbrook into Portsmouth (R.V. Fire Bde. H.Q.) and four detachments from 74 Coy. were brought forward from Hayling Island to Fort Purbrook. A small recce party from Group H.Q. had meanwhile left for the R.V.

A rapid reconnaissance of the main fire zones with the Fire Brigade Chief established that Portsmouth's main shopping centre and the Southsea roads flanking it were uncontrollably alight, a stiff breeze was spreading many major fires and the incidence of these was such that a complete burn-out of the entire area was inevitable if fire breaks could not be made. The air attack, although much diminished, was still in progress.

Much of the property was of the traditional terrace type of three stories with much woodwork. The layout comprised widely separated side streets.

It was quickly agreed that task No. 1 should be the stopping of the three most threatening terrace fires by the demolition of buildings agreed by the Police and the Fire Brigade. Three detachments of 65 Coy. waiting at the R.V. were deployed. Police and firemen sponsored the entrance into intact dwellings and where necessary helped to evict the occupants—a most melancholy proceeding. Small charges, amounting in all to 100 or 150-lb. of gelignite per building, were placed in the basements or ground floor rooms and fired when completed. All demolitions were successful and were accomplished between midnight and 0100 hrs. In each case the building was dropped leaving the characteristic clear cut. In each case also the effect of the explosion and the scatter of the rubble debris put out the fire which had just reached the roof members of the building dropped.

With the consequential laying off of many hoses, supplies of water elsewhere so improved that the many brigades at work in this Southsea sector were able to get control of other fires sufficiently for their leaders to declare that further spreading could be prevented. At this point the air attack ended and as no more demolitions were needed the R.E. parties stood down at 0500 hrs.

Although the fire-fighting in Southsea during the daylight hours on 11th January was successful, fires in parts of Old Portsmouth were, at nightfall, beating the firemen. There was much apprehension about a return enemy visit when the moon rose. So once more R.E. help was invoked at 1930 hrs. that evening. The detachment of 65th Coy. not engaged the previous night together with the detachments of 74th Coy. were directed to the R.V. and the same procedure followed by the small Gp. H.Q. "R" Party. Again large unbroken blocks of small terraced houses were obviously menaced in the strong breeze. As a first instalment two fire breaks were demanded by the Fire Operations Chief. These were contrived by the dropping of a corner workshop/factory premises of old brick construction, which was already well alight and the other by dropping a house next to the head of the flames in a terrace. Again in both cases the explosions and the old dusty rubble put out the flames. As these successes put a much better aspect on the fire situation further parties were not used and the civilian fire brigades carried on without further R.E. help. None of the parties consisted of more than two vehicles and six all ranks. There were no casualties. Thereafter, in Portsmouth, the organization of joint civilian/military effort was recognized as being of the

first importance. The following month 2 C.W. Gp. left the Hampshire coast for Suffolk and Essex. Efforts to interest the civilian authorities of the larger towns in which we were billeted evoked only a tepid enthusiasm. At that time they had been spared real bombardments and during our stay no occasion arose to seek our specialized help, but without prejudice to our other commitments we always had fire-break detachments standing by during alerts. Neither did any opportunities present themselves during the group's service with M.E.F. to give a repeat performance.

Candour demands that mention should be made of some unwise use of explosives immediately after this blitz. At the urgent request of the civil authorities we undertook the clearance of many obstructions hampering communications and likely to be a nuisance when the attack was renewed. Likewise many now dangerous structures needed dropping before high winds or further blast brought them down at inconvenient times. At this time of great confusion and disorganization we were for a few days entirely dependent on hand tools and methods and when these were inadequate fell back on explosives. Luckily no casualties were caused nor important services disrupted (as they might well have been) and we quickly placed an embargo on the use of explosives when, at 1530 hrs. on a fine afternoon, a foot of R.S.J. came sailing over Portsmouth Station to pitch into the main square within a few yards of the Group report centre. However, by then the worst of the obstructions had been removed and supplies of more orthodox demolition resources were being made available and all concerned were contemplating any further bombing with greater confidence. A useful rule is to restrict the use of explosives to the blitz proper and its immediate aftermath, but the corollary is the adequate provision of other demolition resources.

It is not claimed that these Portsmouth experiences have any particular lesson for areas of reinforced concrete construction which in any case are not subject to the terrace fire hazard. Neither have they any bearing on the " fire storm " problem. They are applicable only to the problem of normal blitz fires in terraces and buildings of similar construction, where normal fire fighting methods have been defeated and it is a matter of importance to arrest the spread of the fire.

They absorb an unimportant amount of engineer resources which might otherwise only be standing to. It is the kind of job which any trained engineer unit can tackle and it is probably the one job in Civil Defence which R.E. can take in its stride and do better than any other arm. This is no reason why civilian squads should not be trained ; perhaps they are in these days. Nevertheless it would be prudent for all sappers to be ready to undertake such work in support of the Civil Power.

ROYAL AUSTRALIAN ENGINEERS—ROLL OF HONOUR, 1939-45

THE 1939–45 Roll of Honour for the Royal Australian Engineers was dedicated and deposited in All Souls' Chapel (more generally known as the Kitchener Chapel) in St. Paul's Cathedral on the morning of 28th October, 1949.

The book was handed to the Dean of St. Paul's, the Very Reverend W. R. Matthews, K.C.V.O., by the Deputy High Commissioner for Australia, Mr. N. R. Mighell, C.M.G., who said :—

" Mr. Dean, I request that this Roll of Honour containing the names of 1,161 Royal Australian Engineers, who died on service during the 1939–45 War, may be accepted and housed in this Chapel in everlasting remembrance of their sacrifice."

The Dean accepted the book on behalf of the Cathedral for perpetual safe keeping. The book was then placed on the special cushion on the Altar, on which the various Rolls of Honour of the Corps of Royal Engineers and those of the Dominion and Indian Engineers for both world wars are placed in turn.

The book was then dedicated by the Dean with a short service.

This Roll of Honour, which is the first to be completed for any of the Corps of Engineers for the 1939–45 War, is on similar lines to those of the other Dominions which were prepared for the 1914–18 War and in this respect differs from the large 1914–18 Australian Roll of Honour, which was also on view at the ceremony.

The new volume is bound in a purple blue morocco leather with gold lettering and a gold reproduction of the Royal Australian Engineers' badge, as shown in the photograph opposite.

Inside are two ornamental pages, one having the R.A.E. badge in colour and the other with a drawing of the Cross of Remembrance and the superimposed Sword of Sacrifice. A photograph of this page is also reproduced.

The names are arranged in two columns on the following pages in alphabetical order with ranks, initials and date of death.

When not exhibited on the Altar the Rolls are kept in a locked recess in the wall of the Chapel. This recess, originally designed for the 1914–18 Rolls of Honour, has recently been modified to provide space for the 1939–45 Rolls of Honour.

It has ornamental open metal grill doors, with glass behind the metal. The recess is lined with cedar wood and has a folding lectern which can be drawn out and on which any of the Rolls can be placed in order to read the names. The whole recess is illuminated by hidden electric lights so that the Rolls can be seen through the grill doors.

Any visitor can ask the Verger for the recess to be opened and to be shown any of the books.

Besides the Deputy High Commissioner for Australia, Brigadier E. W. Woodward, D.S.O., O.B.E., the Australian Military representative in the United Kingdom, and several other Australian officers on duty in England were also present.

The Chief Royal Engineer, General Sir Guy C. Williams, K.C.B., C.M.G., D.S.O., and Brigadier I. L. H. Mackillop, C.B.E., representing the Engineer-in-Chief, attended on behalf of the Corps of Royal Engineers.

Major-General R. P. Pakenham-Walsh, C.B., M.C., who was one of the first British Officer Instructors at the Military College in Australia, was also present with his Australian wife.

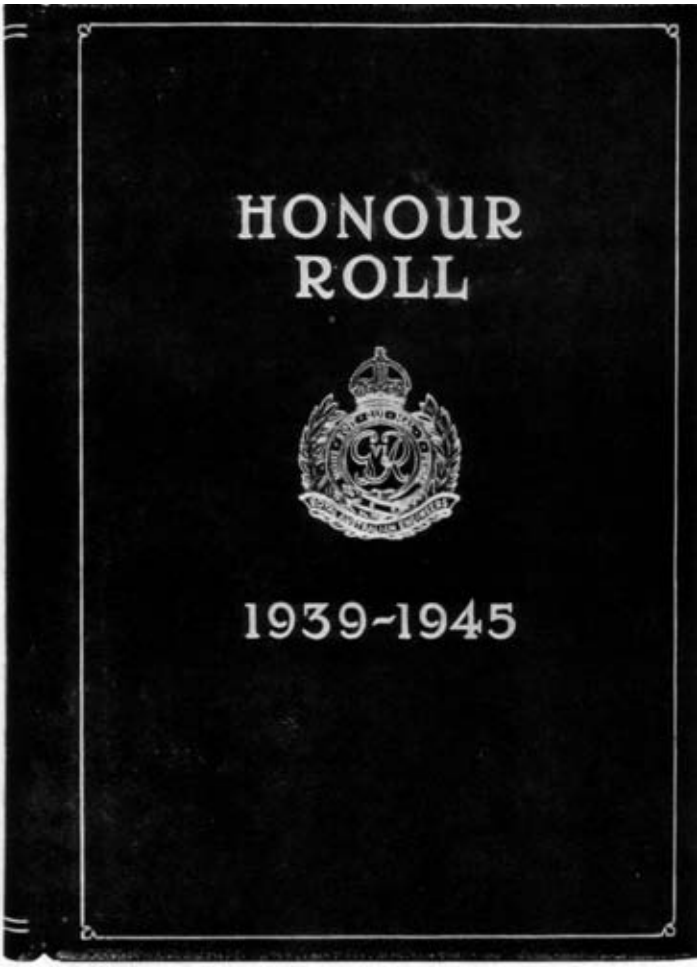


Photo 1.—The leather cover of the Roll of Honour.

Photo 2.—One of the internal ornamental pages.

MEMOIR

COLONEL K. J. LEE, M.C.

KENNETH JAMES LEE, who died on 29th January, 1949, at the age of 55, was the second son of the late Lieut.-Colonel L. H. Lee, R.E. Educated at Bedford School he passed into "The Shop," where he became under-officer and gained "reps" for rugger and fencing.

He was commissioned in July, 1914, and joined 1 Field Squadron, R.E., in France in 1916. Wounded in action in the same year he returned to duty in France as Adjutant, R.E., 49 Division in 1917, having meanwhile been awarded the M.C. From 1918 to early 1919 he was with 57 and 202 Field Companies, holding the acting rank of Major for some eight months.

After a supplementary course at Chatham he was an instructor in English at the École Militaire du Génie at Versailles during 1920 and 1921, joining the K.G.Vs.O., Bengal Sappers and Miners at Roorkee in November, 1921. He commanded 6 Field Company in the Peshawar District and Waziristan from 1923 to 1927, and then was successively S.O.R.E. to the Colonel on the Staff, R.E., and D.A.A.G., A.H.Q., Simla until 1932, obtaining his majority in February, 1929.

In 1926 he married Miss Ethel Jackson, daughter of the late James Jackson, Esq., J.P., of Penrith, who survives him.

After a short period as G.E., Madras, in 1932 he joined the R. Bombay Sappers and Miners at Kirkee in early 1933 as Superintendent of Instruction. Later he commanded the Training Battalion at Kirkee for nearly three years, being promoted Lieut.-Colonel in June, 1937.

In January, 1938, he went to Roorkee as Commandant of the K.G.Vs.O. Bengal Sappers and Miners. Severe and sudden illness incapacitated him for some months, but he was back at duty before the outbreak of war and was able to play his full part in the subsequent great expansion of his Corps.

Promoted Colonel in June, 1940, he went to East Africa in 1941 as D.C.E., returning to India at the end of that year to be appointed A.Q.M.G., Southern Command. Some six months later he was appointed D.C.E. Engineer Troops, Agra, and continued in that appointment until 1945 when he returned to England. After a few months as President W.O.S.B., Oxshott, he retired in June, 1946.

To know Kennie Lee was to love him. Capable, athletic and of commanding presence, he was withal exceptionally modest and never paraded his talents, but those who dealt with him, whether as superiors or as subordinates, soon realized that here was a man who could be thoroughly trusted. Though far from loquacious, he was when necessary forthright in voicing his views: and once set on his course was not to be frustrated.

His powers of steady drive were enhanced by a genial, generous and above all, kindly nature, which produced results in the most intractable material where soulless exercise of authority would have failed.

He never spared himself, and his exertions during the war, coming so soon after a severe illness, must have contributed to his untimely death.

And now, having run the straight race, he rests in peace, secure in the hearts of his friends.

H.W.R.H.

BOOK REVIEWS

AN OUTSPOKEN SOLDIER. HIS VIEW AND MEMOIRS

By Lieut.-General Sir Giffard Le Q. Martel, K.C.B., K.B.E., D.S.O., M.C.

(Published by Sefton Praed. Price 21s. 0d.)

General Martel's book *An Outspoken Soldier* is mainly good; but in parts it is open to criticism. The author forestalls history by his strictures on generals and statesmen in the Second World War. These strictures are uttered in such strident tones that they drown the author's praise of the Army as a whole and of one or two generals in particular. Moreover, as only one side of the case is presented, the reader feels that the last word has not been said.

So too, in the argument in favour of two types of tank (one heavy infantry tank and one light cruiser tank) only one side of the case is presented. The reader should be told of the other set of arguments in favour of one "all purpose" tank: a set of arguments which Alanbrooke and Montgomery found compelling at the time and which is still upheld by many experienced tank officers.

Finally there are many misprints (e.g. W.O.S.B.Y. on page 325).

Now for the other side of the medal. A fresh crusading spirit pervades the pages. The author traces the growth of the tank idea; how it was cultivated by a band of enthusiasts; and how those enthusiasts were proved right in their theories by the tests of war.

There are accounts of the campaigns in the Middle East, the Eastern Front and in N.W. Europe, to illustrate the impact of armoured forces in them. There is an explanation of why we had an inferior tank against Rommel in the early desert battles, and why we had nothing comparable with the German Tiger in Normandy.

There are some excellent chapters on Russia. The author took an accurate view of the Russian mentality. He attributes most of the annoying Russian manœuvres to the Communist Party's fear of losing face. If prestige is affected they at once become truculent. The picture of life in the Military Mission in Moscow is vividly drawn.

Soldiers will like the chapter on "Amateur Sport." It is very invigorating and puts the professional player in his proper rôle; that is as a teacher. The plan to enliven cricket will appeal to many readers. His suggestion for limiting the overs allowed each side is already commonly adopted on "a squadron level," though the M.C.C. shows little tendency to follow suit. The chapter on tiger shooting is first class.

But perhaps the most important chapters are on the present ills of Britain and her Army and what should be done to right them. Conscription is roundly condemned and the War Office organization gets a punch on the nose. The remedies suggested deserve thought. The reader will, however, again regret the absence of the other side of the argument.

Regimental officers will like the book. The author commanded a section of a field company in the first war, a field company between the wars, and the 50th Territorial Division at Dunkirk. He never lost the human touch of the good soldier. "There can be no excuse for any officer who puts any consideration of his own personal position before that of the welfare of his men," epitomizes the author's outlook.

Perhaps I may be permitted to say of this book what its author wrote on a military essay of mine in 1930. "This might have been excellent. As it stands it is patchy." None the less it is worth reading, for one can always skip, and even scandal is quite entertaining.

M.C.A.H.

ARMED PILGRIMAGE

By J. V. DAVIDSON-HOUSTON

(Published by Robert Hale Ltd. Price 15s. 0d.)

Davidson-Houston (he omits his rank on the title-page) has written a book which many service readers will enjoy. Beginning in 1904, when the author was in the nursery, he describes the development of Japan as seen through Western eyes. He is well qualified to do this, for as a regimental officer, as an assistant military attaché, and as a tourist, he began his *Armed Pilgrimage* in the Far East and remained there off and on from 1928 to 1938. Next he describes a kaleidoscope of events and travels in Roumania the Middle East, Persia, China and Burma. He ends his story with the "Dawn of Victory" under Wingate in 1944.

It is a tale well told. The author has a practised command of the English language; his words and periods fit like pennies in a slot. There is plenty of wit, though sometimes unsuited to Victorian maiden aunts. He shows great skill in his renderings in English of what foreigners, particularly orientals, say in their own tongue, thereby revealing something of their process of thought. Take, for instance, the following conversation between a Mongoloid brigand and the author.

The Mongol asks:

"Does England have an Emperor?"

"Yes," I answered, "a good one."

"Is it necessary to approach him on hands and knees?"

He also conveys to the reader why orientals find the Englishman somewhat annoying. The author is in a train in Manchuria, when an inquisitive Jap asks him:

"Have you a . . . ah . . . licence?"

"Fish licence?" I returned.

He sucked air and tried again:

"Shoot licence?" I suggested.

Eventually I prevented his bursting by crying:

"Ah, you mean passport. Yes I have one."

In his travels the author was present from time to time at bacchanalian orgies. Here is scope for his ready wit to which he gives full rein. For instance: ". . . the only lady present, toyed anxiously with her vodka glass, terrified lest she should suddenly burst into flames." Or this: "That night the pipes and drums of the Cameronians came into the Headquarters Mess tent and the air was filled with pibrochs and whisky vapour as we danced reels until all was enveloped in a cloud of dust."

His descriptions of places and scenes are vivid. He conjures up before the mind's eye the "grime and garbage" of Constantinople Harbour, the ruins of Bardia, the banks of the Jordan, dawn in Kurdistan, and the Burmese jungle; all with equal felicity.

He gives us a fleeting view of Wavell, woken from sleep and patiently listening to ill tidings. We see a good deal of Stilwell in the retreat from Burma; and we have glimpses of Alexander at about the same period. We meet Wingate, consumed by impatience, hurrying to Chunking; at a family party in Mayfair; in India; and in Burma. The author says of him "My first impression of Wingate . . . was that he was intelligent, determined and courageous, but self-opinionated and intolerant."

In all, it may be said that the author describes a varied and interesting military career. It is the kind of career which inevitably comes to a man with a gift for languages and a leaning towards the unorthodox. It is an excellent account of a side of soldiering which few regular soldiers know. Better accounts of this sort of thing are uncommon.

M.C.A.H.

BADGES ON BATTLEDRESS

By LIEUT.-COLONEL H. N. COLE, O.B.E., T.D.

(Published by Gale & Polden Ltd. Price 6s. 0d.)

After the 1939–45 War, Lieut.-Colonel Cole wrote a most interesting book entitled *Heraldry in War* which gave details of all the war-time formation signs. It was a wonderful historical record which will be of great value to future officers who may have to deal with the selection of badges and signs.

His latest work continues on from the former and shows how in peace-time, with a greatly reduced number of formations, the war-time heraldry has been continued.

Some of the old signs still continue, some have been combined and others have been changed completely in view of changed conditions. In these days of rapid travel, personnel from all parts of the world are seen on leave, on duty and on courses, etc., in this country with many different types of badges. This little book will prove of infinite value to everyone to answer the question that so often arises: "That is a new badge to me. What formation does it represent?"

C.C.P.

THE CAGE

By DAN BILLANY AND DAVID DOWIE

(Published by Longmans, Green & Co. Price 9s. 6d.)

The authors of *The Cage* were two young officers who were captured in Tobruk in June 1942. Their story of life in Italian P.O.W. Camps is typical of the experience of many others who were put in the bag at the same time, except for the last unwritten chapter of their lives.

After the Italian surrender in September, 1943, they had three months of freedom, but have not been heard of since. It is presumed that they were both killed attempting to escape when in transit from Italy to Germany, although it is not certain that they were ever recaptured. The manuscript of the book was left with an Italian farmer who sent it to England at the end of the war.

The first part of the book is about their life in Capua, a so-called transit camp for 150 officers. The authors were unlucky in being there for five months, a grim enough experience in any transit camp, but they succeed in

giving a very lively description of P.O.W. life, and for hungry men they treat the serious subject of food with remarkable flippancy.

The attitude of the Italians towards their prisoners is clearly portrayed in the Commandante and his staff, with their promises to get things done "domani" and their trigger conciousness whenever anything unusual happened.

From Capua the scene moves first to Rezzanello, and then to Fontanellato, both better camps but in a colder climate.

The second part of the book is more a psychological study of the reactions of various officers to their imprisonment. It is still excellent reading, but serious in thought, as though the authors had suddenly gained in maturity.

The book cannot compare with *The Wooden Horse* for excitement, but it stresses the seemingly unimportant details of a prisoner's life which meant so much to him at the time.

By being in the form originally conceived by its authors, the book has not suffered from any pruning or afterthoughts influenced by a return to normal life.

C.C.A.R.

WELDING TECHNOLOGY

By F. KOENIGSBERGER

(Published by Cleaver-Hume Press Ltd., London. Price 21s. 0d.)

The author of this book gives a very comprehensive and masterly description of welding in all its various stages and applications, and of welding equipment.

In the early chapters he deals with the advantages and the limitations of welding and makes comparisons with other methods of joining metals. In the general survey, he has split up the welding processes into two main groups, viz; "fusion welding processes" and "forge welding processes" and has devoted a chapter to each group.

In the first group, oxy-acetylene, carbon arc, metallic arc, atomic hydrogen and thermit welding are described and amply illustrated by sketches, diagrams and photographs. In the second group, the chapter on forge welding processes, deals very thoroughly with blacksmith and water gas welding. Numerous tables are included under the above two headings, which give plate thickness, number of runs, gauge of electrodes, current consumptions and also full details for welding by the deep penetration method.

Various machines and diagrams are described and tables giving machine settings for resistance welding and projections for projection welding are very clearly explained.

The chapter on welding ferrous metals is good and fully explains the causes of cracks in the weld itself and in the vicinity of the weld and the parent metal.

It is shown why the rate of cooling is of great importance and how the carbon content of the parent metal and filler metal determine the influence of the quenching effect on the ductility in the region of the weld.

Dealing with stainless steels, the author shows how they can be readily welded by the argon arc and the atomic hydrogen process and, due to the shroud of gas which is formed around the arc, the weld is protected against oxidization. He points out a peculiarity that the corrosion resistance may be effected due to the slower cooling of the parent metal than the weld itself, thus affecting the crystal boundaries.

The welding of non-ferrous metals is well described and numerous tables giving machine settings and gas consumptions are included in the chapter.

Oxy-acetylene plants and their component parts, such as cylinders, regulators and high and low pressure blow pipes, are amply illustrated.

The equipment for arc welding is next explained and illustrated by diagrams. Typical sectional arrangements of D.C. welding equipment are also given. The details and descriptions of electrical equipment for resistance welding is very ably set out and described at length, the wiring diagrams being particularly explicit.

The process of flame cutting and flame gouging for the preparation of plate material is clearly set out and, together with numerous photographs of equipment, diagrams and tables, it forms a very interesting chapter.

In the section dealing with manipulators and fixtures, the author has shown how very large fabricated pieces of plant can be manipulated to give the welder the best working position for quick and effective fabrication.

To the operator, the chapters on safety precautions, plant maintenance, and distortion and residual stresses contain very useful information, whilst the chapters on weld strength and faults, design principles and estimating, are most useful to the designer, draughtsman and estimator. Details of a fabricated gear box and the metal cutting drawing for the fabricated portions show the advantages which welding has over casting for this particular design. One illustration shows a reduction of approximately 40 per cent in weight between a riveted structure and a welded structure designed for identical duties.

There is a good index and cross reference for consulting on specific points.

In conclusion the author is to be complimented on all the useful and up-to-date information he has so ably placed into this volume and which is so clearly and concisely written.

C.S.B.

THE MECHANICS OF ENGINEERING SOILS

By P. LEONARD CAPPER AND W. FISHER CASSIE

(Published by E. & F. N. Spon, Ltd. Price 21s. 0d.)

This book is designed to show the influence of soil mechanics on foundation problems. It covers soil origin, identification and classification, site investigation and soil sampling, a study of the engineering properties of soil and the tests involved and a study of engineering problems affected by these properties.

The engineering problems considered are divided into four main groups:

(*a*) Earth pressure, including the stability of retaining walls and earth slopes.
(*b*) Foundations and structures.
(*c*) Subgrades of roads and runways.
(*d*) Drainage problems.

The book covers no new ground but is, rather, a summarised presentation of commonly accepted principles and theories. As such the approach is more academic than practical. The method of presentation is extremely lucid, the text is amply supplemented with graphs and other figures and the authors have largely overcome the problems evoked by large-scale use

of symbols by providing a notation at the start of each chapter. Even so it is still a little confusing to find one symbol (m) representing such diverse items as moisture content, the reciprocal of Poisson's ratio and the ratio perimeter/radius of a pile. In some instances worked examples have been included and a comprehensive bibliography is given at the end of the book.

Two curious omissions are worthy of comment. The first concerns soil classification. Page 34, referring to Casagrande's system, indicates the use of consistency limits (Atterberg) tests in identifying cohesive soils. While these tests are themselves adequately described their use to this end is not made clear. This omission can be repaired by reference to "Soils, Concrete and Bituminous Materials" (H.M.S.O.) Fig. C17. The next omission refers to moisture and the effect upon soil properties caused by changes in moisture content. While this effect has been mentioned in many passages in the book under review, all these passages have referred to the movement of moisture in the liquid phase. No mention at all has been made of the considerable movements of moisture that may and often do occur in the vapour phase. These vapour movements are associated with temperature gradients and although, in this country, the daily atmospheric temperature cycle is unlikely to cause moisture migrations on a large scale, the same cannot be said of the annual cycle nor of temperature gradients artificially induced by virtue of heating or cooling plants installed in structures superimposed on the soil.

These comments should not be allowed to detract from the value of this book when viewed in its proper context. As a reference book for an experienced engineer its value is very considerable. A beginner, and especially one with no marked mathematical ability, will be well advised to "Go canny."

A.F.L.

STRUCTURAL ANALYSIS BY MOMENT DISTRIBUTION

By S. BUTTERWORTH

(Published by Longmans, Green & Co. Price 10s. 6d.)

"Moment Distribution" is a method of analysing indeterminate structures, such as continuous beams and portal frames, and was first introduced by Professor Hardy Cross in 1929. It is widely used in the U.S.A. and, deservedly, is becoming increasingly popular in this country. It has the advantage over older methods, such as "strain energy," that, once a few simple principles have been grasped, any problem, however complex, can be solved to any required degree of accuracy by simple arithmetic. Instead of solving a number of meaningless simultaneous equations, the engineer is kept aware, throughout the calculation, of the way the loads are distributed to the members of the structure.

Butterworth's book explains the method in simple language, and shows how to apply it to continuous beams, portal frames, frames with sloping legs and multi-bay, multi-storey frames. The reader requires only an elementary knowledge of bending moments, though for a full understanding of the theory he requires some knowledge of "Slope Deflection" equations for a beam. A feature of the book is that the method is described almost exclusively by means of worked examples. Since Moment Distribution is more of a technique than a theory, this is undoubtedly the best way of explaining it.

In Part I, the author shows the application of the method to continuous beams with free and fixed ends, and the effect of sinking supports. He gives a brief mention of Grinter's design method and finally shows the theoretical

principles involved in Moment Distribution. Part II deals with portal frames of all types, frames with sloping members and more complicated building frames. An appendix shows useful methods for checking answers, and there are a number of advanced exercises at the end.

The book does not show in detail the application of the method to secondary stresses or the more difficult problems of non-uniform members and semi-rigid joints, but there are references to a full bibliography at the end. The typescript and diagrams are clearly printed and the volume has the advantage over the majority of engineering textbooks of only requiring a third of an inch of shelf space.

In general, this book can be strongly recommended to anyone who wishes to learn or relearn what is a fascinating and important new method of analysing structures.

M.E.T.

PRESTRESSED CONCRETE

(Published by The Institution of Civil Engineers. Price 7s. 6d. post free)

This is a record of a conference held at the Institution of Civil Engineers in February, 1949. It contains a lucid review by Dr. F. G. Thomas, M.I.C.E., of the present constructional technique followed by an informative discussion on widely different technical aspects of the subject. The economic aspect is briefly considered, and it is interesting to note that prestressed concrete bridge designs have been accepted in competitive tendering in Belgium, France and the U.S.A.

After summarizing the historical development and early failures, Dr. Thomas stresses the high quality of materials necessary for success. The steel commonly used is hard drawn wire with an ultimate tensile strength of 100 tons per sq. in. for 0·2 in. diameter wire. Recommended design values are given for losses in prestress of the steel due to elastic deformation, shrinkage and creep of the concrete. Research to date on the probable creep in the steel is described.

The concrete must have a mimimum 28-day cube strength of 6,000 lb. per sq. in. Close control of the grading and moisture content of the aggregates, the water/cement ratio and the compaction (by vibrators) is essential.

The " pre-tensioning " system is normal for pre-cast work. The comparative merits of the " long-line " (Hoyer) process and the " individual unit " process of pre-tensioning are considered. Methods of reducing the time of hardening of pre-cast units in order to achieve early removal from the moulds are discussed. Such methods include the use of calcium chloride as an accelerator, steam curing and electrical curing.

The " post-tensioning " system is suitable for cast-in-situ work, and either the Freyssinet or Magnel method of tensioning and anchoring is normally used. An alternative use of the post-tensioning system is to pre-cast small units and connect them together at site on wires which are then stretched. An electric system of post-tensioning is also described.

Useful information is given on bridges, including brief details and cross-sections of existing prestressed bridges in various countries. Depth/span ratios of as little as 1 : 18 to 1 : 22 are usual. Slabs can be used up to 80 ft. span and beams up to 200 ft. or more. For beam bridges it will save formwork by pre-casting at site in one mould across the span, each beam being moved sideways into its final position after prestressing.

British developments in prestressed concrete are well described, including pre-cast pre-tensioned bridge beams (Ministry of Transport and British

Railways) pre-cast railway sleepers, and a post-tensioned bridge (Freyssinet system) (Nunn's Bridge, Lincs.)

The use of prestressed concrete in tanks and reservoirs, dams, pipes, piles and buildings is also covered.

Prestressed Concrete forms an excellent summary of present practice, and many uses of prestressing are clearly demonstrated. The booklet is well illustrated by photographs and diagrams and there are two useful appendices; one a list of existing British patents on prestressed concrete, the other a comprehensive bibliography.

A.S.B.

SCIENTIFIC AUTOBIOGRAPHY AND OTHER PAPERS

By MAX PLANCK

(Published by Philosophical Library (New York). Price $3.75)

Max Planck, whose work in founding the Quantum Theory at the beginning of this century entitles him to rank, with Einstein, as one of the great creative intellects of this age, died two years ago at Gottingen, and left behind him a number of unpublished essays and papers which are now presented in English for the first time. He was nearly ninety when he died, and these writings, which all date from the last ten years of his life show the fruits of his patient deliberation, over a period of sixty years and more, upon the underlying philosophical and religious significance which he attached to the transformation of scientific outlook during his lifetime.

The first paper, a simple autobiographical account of his long life's work, suggests an attitude and a mentality which the subsequent essays disclose quite fully: the mind of a man who was, like Newton, fully content "to think God's thoughts after him," and who rejoiced to find that his pursuit of the universal and the invariant in physical science led him, no less surely than his deep religious convictions, to an understanding and an experience of that Absolute beyond all relativity which is God.

"No matter where and how far we look, nowhere do we find a contradiction between religion and natural science. On the contrary we find complete concordance in the very point of decisive importance." This is the central thesis of the book, which is developed in three essays on "Phantom problems in science," "The meaning and limits of exact science," and "The concept of causality in Physics" and brought to completion in the final paper "Religion and Natural Science." Throughout, his thought is characterized by tolerance and discipline, and he finds a resolution for all the paradox in nature (particle and wave-packet, body and mind, freewill and causality) in recognizing that such concepts represent equally valid interpretations of a *single* reality, but seen from two different and mutually exclusive points of view.

Planck was no easy optimist. "I have never succeeded in gaining universal recognition for a new result, the truth of which I could demonstrate by a conclusive, albeit only theoretical proof," moreover "A mere scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it." But he possessed an unbounded confidence in the power of truth ultimately to prevail, and in that faith he leaves us with his final message; a rallying call to renewed vigour in the crusade against superstition, dogmatism, and disbelief, which is clear, fruitful, and coming from whom it does, deeply reassuring.

W.H.B.

TECHNICAL NOTES

THE DETERIORATION OF CONCRETE IN STRUCTURES

(*Journal of The Institution of Civil Engineers*, dated May, 1949.)

The various major causes of deterioration in concrete, based on information drawn from field trials and laboratory tests carried out by different agencies, are discussed in this paper and the preventative measures are outlined.

In order to resist attack by outside deleterious substances in solution, a well matured concrete of impervious mix with low water/cement ratio is recommended.

Drying shrinkage, poorly made construction joints and thermal movement may all contribute to concrete failure. In the latter case, choice of aggregate with a low thermal expansion may minimise cracking where variable temperatures have to be contended with.

Deterioration can be lessened by careful choice of the constituents. Thus unsuitable aggregates, which have forms of silica present which react with the alkalis in the cement to cause gradual expansion, are to be avoided. When angular aggregates are used the mix must be made workable by an increase in the cement and not by the addition of water, which is more usual and which leads to a decrease in strength.

Certain cements, such as high-alumina cement, are stated as being more resistant to deterioration than others under conditions of exposure to sea-water, ground waters containing sulphates, and atmospheric attack by acid gasses, but are not so suitable as other cements for work in the tropics.

Chlorides present in sea water greatly accelerate the corrosion of steel especially just above water level, but plain concrete does not deteriorate so rapidly.

Air entrained cement gives increased durability and is said to offer greater resistance to frost action.

PRESTRESSED CONCRETE PIPES

(*The Engineer*, dated 25th March, 1949.)

Concrete pipes with a 7 ft. internal diameter and covered with a heavy concrete casing were required for the Montreal water supply intake from the St. Lawrence River.

The civil engineer required 532 pipes, 84 in. internal diameter, 18 ft. long with 5½ in. thick walls and each weighing about 16 tons.

The design submitted by the Preload Company, Montreal, Canada, showed that by prestressing the concrete a saving on the requirements of normal reinforced concrete of 800 tons of steel and 10 per cent cement could be achieved.

Pipes were prestressed both longitudinally and circumferentially, the longitudinal wires being pre-tensioned and the circumferential wires post-tensioned.

Three pipes were made per 8-hour shift and steam curing was applied for 72 hours. The inner form for the pipes was a steel cylinder with a single longitudinal joint which could be contracted to reduce the diameter of the cylinder by 1½ in. for withdrawal. The outer steel forms were placed and the concrete poured in two lifts, internal vibrators being used.

UNDERWATER BLASTING

(Civil Engineering and Public Work Review.)

A series of interesting articles on " Underwater Blasting " by R. Westwater B.Sc. and R. Haslam B.Sc. are appearing in the current issues of the *Civil Engineering and Public Works Review.*

Part 2 of the article in the August issue is of particular interest to Field Engineers. It starts off by describing the various methods of firing a number of charges simultaneously. First is the normal method of firing a number of low tension detonators (such as the standard service No. 33 detonator) in series by means of an exploder. It discusses the currents required and the various types of exploder used in civil practice including the " Beethoven " Dynamo Condenser Exploder which is the standard service exploder. The desirability of having ample reserve power in hand over the rated capacity of the exploder is stressed.

The use of parallel and parallel-series circuits is discussed, the latter are normally used when the power is taken from the mains.

Waterproof primers are particularly important, because the sensitivity and the velocity of detonation of an explosive decrease as the head of water increases. The reason for this phenomenon is complex, but, to generalize, it is thought that it is closely related to the quantity of air contained in the explosive. The air is in the form of minute globules or bubbles and as the head of water increases the bubbles are compressed. In this way the air will be gradually squeezed out of the explosive resulting in an increase in density and consequently there will be a corresponding gradual reduction in the sensitivity and the velocity of detonation.

There are a few remarks on Shaped Charges. The use of the Stock type charge for metal cutting is mentioned, and its application to wreck cutting will be described in Part 3 of the article. This technique, using normal cartridges of plastic explosive with a segment cut out along their axis, has been the subject of a report recently issued by the U.S. Corps of Engineers and was also described in R.E. Training Memorandum.

Finally Part 2 of the article discusses equipments for drilling and charging.

THE REPAIR OF A BREACH IN THE CALEDONIAN EMBANKMENT, 1947

(The Dock and Harbour Authority, dated July, 1949.)

This article describes the repair of a breach which occurred in the embankment which forms the west side of the Caledonian Canal and the east bank of the River Oich. The breach occurred in a most isolated and inaccessible spot, and the possibility of rain made extensive damage very likely.

A condemned " swim " barge of about 50 tons capacity was hand towed through the breach and sunk in the lagoon formed by the escaping canal waters. An excavator, working in the river bed filled the barge with shingle and then loaded shingle into dumpers which moved, on steel planking, over the barge and tipped the material into the flooded gap.

On the firm base now obtained the excavator was mounted as a pile driver and a line of sheet piling driven along the embankment face on the canal side. Concrete sand bags were laid on the river side using the hatch coaming of the barge to form a toe for the revetment.

The canal was sealed with clay, dumped into the water by hopper barges and placed into position by grab.

STRUCTURAL DEFENCE

(*Journal of the Institution of Structural Engineers*, dated July, 1949.)

This article is written with the object of focusing attention on points to be taken into consideration in the design of bomb-resisting structures. It briefly traces the history of incendiary materials and explosives and discusses the various types of bombs used during the war and the explosive effect and structural measures taken to combat them.

It is noted that the angle of impact can vary from an angle of about 15–16 deg. to the vertical to approaching horizontal, and that the suction wave set up by an explosion is more persistent than the blast wave, has a greater destructive effect and loads a structure in the opposite direction to that for which it is conventionally designed. The use of light fabric is stated to avoid prolonging of the peak pressure from a bomb exploding in a building and minimises its effect. The destruction of load-bearing walls, leading to collapse of a building, may be brought about by a combination of penetration of fragments of bomb and blast pressure.

The enormous destructive effect of an atomic bomb is mentioned in very general terms and it is concluded that fully framed structures possess a measure of resistance which renders them superior to those constructed with load-bearing walls.

This article confirms the efficacy of the steps taken in the early days of the war on new construction, when it was determined that constructions should be designed to avoid reliance on load-bearing walls by using steel or reinforced concrete frames.

The use of roof coverings and wall panels lightly connected to the main structural frame were also advocated so that their removal under blast would be ensured and avoid a build up of internal pressure. Connexions which would minimize the chances of progressive collapse were also recommended.

REPAIR OF EYEMOUTH BRANCH LINE

(*The Engineer*, dated 22nd July, 1949.)

Due to heavy flooding on 12th August, 1948, the Eyemouth branch line was seriously damaged, in common with the main trunk lines between Berwick and Dunbar, and closed for the following ten months. Apart from track damage, major damage occurred at Eyemouth viaduct which carries a single line of railway across the Eye water. The viaduct is 332 ft. in length and consists of six lattice girder spans carried on piers built of concrete with brick facing. The height of the viaduct from rail level to water level is 60 ft.

The river, normally confined beneath span No. 5, extended, due to the flooding, under all the spans, and the scouring action of the flood waters washed away the gravel underlying the centre pier No. 3, causing the pier to collapse, leaving the superstructure suspended. It was also found that considerable scouring had occurred in the bed of the mill lade, situated between piers Nos. 1 and 2, extending some distance under the foundations of pier No. 2.

Remedial measures were begun by rebuilding pier No. 3. Steel sheet piling driven 30 ft. into the gravel formed a permanent cofferdam in which the mass concrete foundation of the pier was constructed at a depth of 12 ft. below bed level.

Pier No 2 was similarly encased in a permanent cofferdam of sheet steel piling carried 25 ft. down to rock, concrete being packed into the scoured

portion under the foundation. A training wall of steel sheet piling, 25 ft. deep and capped with concrete now forms the other side of the mill lade. The scoured position of the mill lade was brought up to within 1 ft. of bed level with packed material from the collapsed pier, and the bed now consists of a concrete mat, 1 ft. thick on top of packed material, which also acts as a strut between the walls of steel sheet piling.

Pier No. 4 being founded on gravel overlying rock, was treated similarly to pier No. 2 to a depth of 12 ft. down to rock. A new cut-water was also provided.

The original foundation of pier No. 5 being on rock, a new cut-water and concrete wall were provided, the wall being carried down to rock and along the river side of the pier and round one end as an added protection.

To enable work at piers Nos. 4 and 5 to be carried out in the dry, the river was diverted into a new channel which has been left to serve as an additional channel in times of flood.

CONTINUOUS RAILS IN CASCADE TUNNEL, NEAR SEATTLE, WASH., U.S.A.

(*The Railway Age* (U.S.A.), dated 9th July, 1949.)

The Great Northern Railroad of U.S.A. has just completed the laying of a 4-mile length of continuous rail in the 8-mile long Cascade Tunnel.

Standard 39-ft. rails were welded into 1,326-ft. lengths by the Oxweld process, near the west portal of the tunnel, and taken into it three at a time on roller equipped flat cars. The closure joints between the long rails were hand welded.

The ¼-mile length welded rails were removed from the flat cars, after being taken into the tunnel, by securing the end to the track by clamp, steel cable and shackle, and then drawing the cars out from under them.

The old rails were unspiked on the inside, tilted out of the way and the new rails lined up and respiked. New tie plates were fitted at the same time but no resleepering or adzing was required.

The work was carried out without interference to traffic. Actually the roller flat cars can carry 25, ¼-mile lengths of rail but only 3 lengths could be handled owing to the need to restore the track before the passage of the next train.

Temporary closures were necessary to make good before hand-welding could be completed. This was effected by securing angle bars (fishplates) to the joint by special clamps, cutting the old rail with a power saw and turning the remaining short length end for end. The next joint of the old rail was then secured with angle bars avoiding any rail drilling on site.

Rail cutting and drilling was, of course, necessary for the four track circuit insulated joints in the tunnel.

The hauling and unloading of three rails from the work train took 2–2½ hrs. and the gang of forty men relaid, lined up and spiked a quarter mile length in about two hours.

In the Oxweld process the rail ends are welded at a temperature of approximately 2,300° F., at a pressure of 2,500–2,700 lb. per sq. in.; each weld takes about five minutes.

The process involves squaring up and smoothing of rail ends by a rail saw, pressure welding, removal of excess metal by oxy-acetylene torch, normalizing by re-heating the weld to remove stresses, grinding and polishing. The welded rails are moved along the assembly line by power winch. Each

weld is tested for flaws by Magnaflux process and the sides of the rails are then flame and brush cleaned to remove mill scale and given two coats of corrosion resisting paint.

The Magnaflux weld testing process consists of dusting the weld by a bellows arrangement with a special powder in the presence of a magnetic field. The pattern assumed by the powder reveals possible flaws or seams not ground out.

FORMATION GROUTING

(*Railway Age* (U.S.A.), dated 12th February and 2nd April, 1949.)

Experiments have been carried out in America on the stabilization of railway formations by grouting.

Figures produced show a great saving in maintenance man-hours and in the amount of ballast required for re-surfacing. In addition, grouting has improved operating conditions by the elimination of speed restrictions. Another point in favour of grouting is the absence of " heaving " in freezing weather.

The equipment used is a Fairmount grouting unit, consisting of a grout mixing unit (pressure vessel in which the mix is agitated by engine driven paddles), a dolly car for transporting the unit, an inclined sand screen with hopper, a 94 gallon tank with fitments, hose, nozzles and accessories.

A typical gang consisting of a foreman and seventeen men, with low fills, can grout 1000 ft. of track per 6 days (8-hour day).

UNUSUAL PRACTICE IN BRIDGE RENEWALS

(*Railway Gazette*, dated 25th March, 1949.)

From the report entitled " Recovery and Strengthening of Metal Bridges that have Reached the Theoretical Limit of Safety " to the International Congress Association, there emerge one or two points of unusual interest. For instance, it is standard practice on the Tunisian Sfax-Gasfa Railway to take up all steel spans of from 12 ft. to 50 ft. in length periodically, and send them to shops for overhaul, like a locomotive. According to whether each individual span is to be re-erected again in the same place or used elsewhere after reconditioning, its place in the road is taken by a temporary or by a new span. Such replacements and repairs are carried out according to a systematic programme, and the practice is considered to be justified financially.

The Netherlands Railways have found it advisable to construct a special vehicle for girder-span renewals. Its inception was due to the necessity for replacing seventeen bridges situated side by side under adjacent shunting roads in a busy yard, and each consisting of two 92-ft. spans. Speed was important and the first of these spans, therefore, was taken to shops, strengthened, and then used to replace another span, thus released for strengthening. The method adopted, to use a free quotation of the report, is as follows : " The special wagon makes it possible to carry the new span above the old one, lift the latter simultaneously with the new one, tipping the whole through 180 deg., and lowering the new span into place. Traffic is interrupted for less than 1¾ hours." Similar type wagons have since been built on various lines for handling and erecting longer spans.

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