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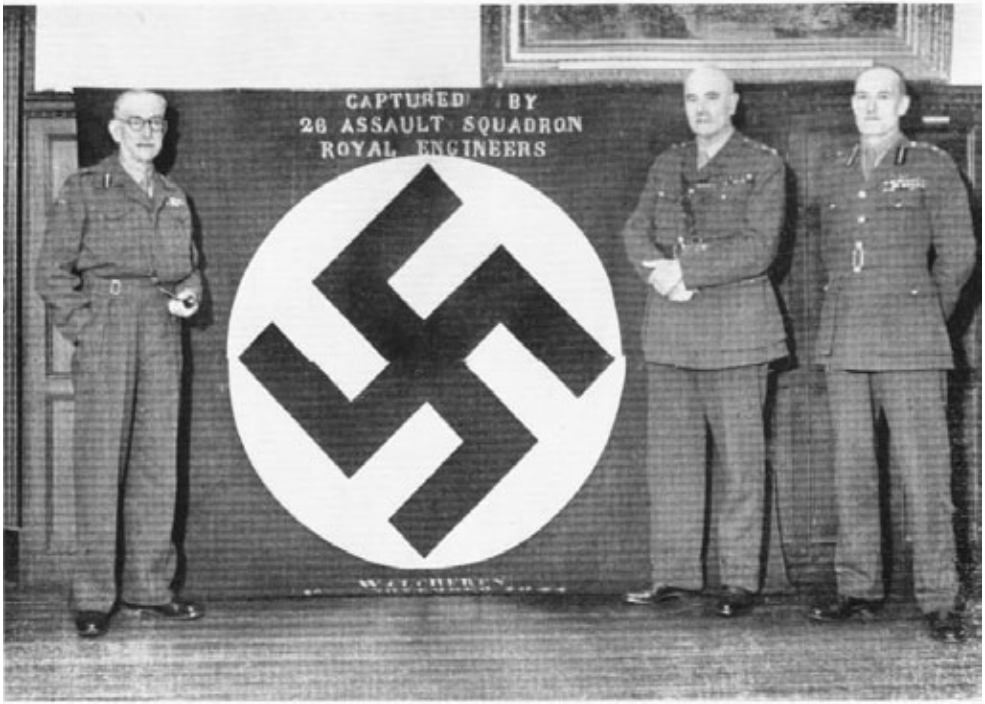

Nazi Flag captured by 26 Assault Squadron, R.E., at Walcheren.

Nazi flag

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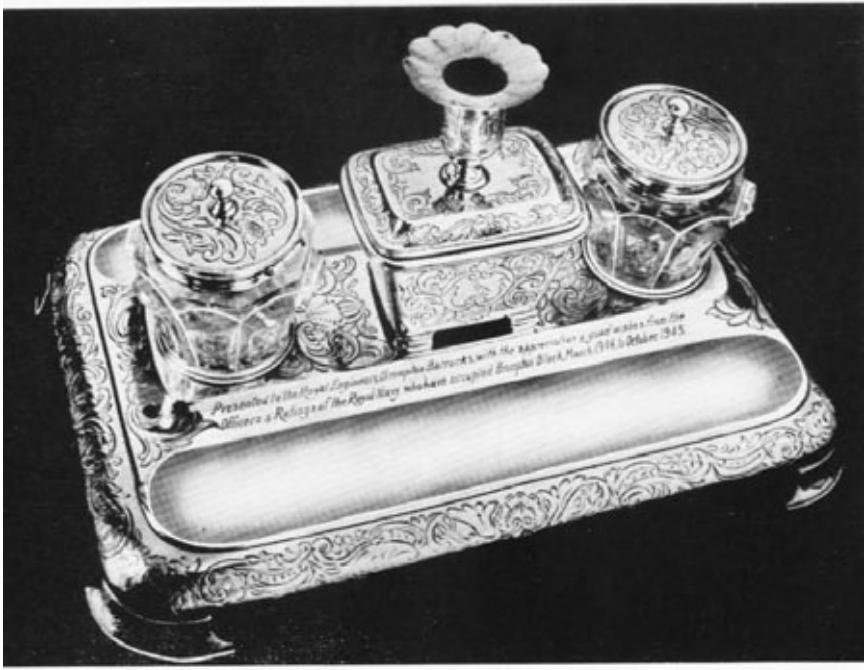
THE ROYAL NAVY TO THE ROYAL ENGINEERS



Silver inkstand presented to the R.E. by Officers and Ratings of the R.N. who occupied Brompton Barracks, Chatham.

Silver inkstand

EDITORIAL NOTES

1. Chatham Wing, S.M.E.

CHATHAM is once again beginning to take a more active part in the life of the Corps. For the past five years the R.E. establishment has consisted of a Training Battalion and a Trade Training Wing. These two units have closed down and there is now at Chatham a Wing of the S.M.E. The Wing consists of a Headquarters, with Col. J. H. D. Bennett, O.B.E. as Assistant Commandant, S.M.E., and Commander, with the Construction School and the Trade Training School. The 7th Training Battalion, R.E., has been reorganized into the 10th Depot Battalion, R.E., and undertakes the administrative duties of the two Schools.

The Royal Navy have vacated the portion of Brompton Barracks, including the Officers' Mess, which they have been occupying during the latter part of the war and one is no longer greeted by the sentry at the Main Gate saying "Coming aboard, Sir?"

St. Mary's Barracks is still entirely occupied by the Navy, and Kitchener Barracks is shared with the Navy, 10th Depot Battalion R.E. occupying Lower Kitchener Barracks, while the Navy occupy the pre-war Boys' Block in Upper Kitchener Barracks.

The total strength of the Corps at Chatham now amounts to approximately 100 Officers and 1,800 other ranks, including personnel on courses. The number of officers is expected to be over 250 in April.

The Officers' Mess at Ripon remains the H.Q. Mess of the Corps, but the Brompton Mess will reopen very shortly. It will be a very welcome relief to the large number of officers now at Chatham, who have had to be accommodated recently in the Kitchener Barracks' Mess, the old Commandant's House and previously also in No. 3 and 4 Staff Quarters.

Brompton Barracks' Mess will have to be run on strictly austerity lines, as much of the original Mess furniture is at Ripon, and barrack room tables will make a poor substitute for the beautiful mahogany dining tables, which were such a pride of the Mess. Only a minimum of redecoration has been possible, and further work will have to await more favourable times and decisions as to the future of Chatham.

On vacating Brompton Barracks the Royal Navy presented the Corps with a most handsome silver inkstand, of which we reproduce a photograph. This will be a treasured memento of the close co-operation between the Navy and the Corps during the time when we shared our barracks together. The Chief Royal Engineer has sent a letter of acknowledgement and grateful thanks to the donors.

2. Presentation of Nazi Flag to the Corps

In the February, 1946 *Supplement* we published a brief description of this ceremony at Aldershot. A picture of the flag is reproduced in this issue of the *Journal*, and shows Maj.-Gen. Sir Percy Hobart, K.C.B., C.B., D.S.O., M.C., Cmd. 79 Armd. Div. who presented the flag to Lieut.-Gen. Sir Ronald Charles, K.C.B., C.M.G., D.S.O., Chief Royal Engineer and Maj.-Gen. Sir Eustace Tickell, K.B.E., C.B., M.C., Engineer-in-Chief.

3. Annual General Corps Meeting

The Annual General Corps Meeting will be held at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1., on Friday, 21st June, 1946, commencing at 2.30 p.m. It is hoped that the Chief Royal Engineer, Lieut.-Gen. Sir Ronald Charles, K.C.B., C.M.G., D.S.O., will be in the Chair.

After the last general meeting a number of officers expressed a desire that some account of the activities of the Corps should be given at future meetings.

It has, therefore, been arranged that the meeting this year shall be divided into two parts. During the first part the usual business of passing the accounts and reports on the various funds will be dealt with. During the second part the E.-in-C. will make a statement dealing with the present and future problems of the Corps.

It is hoped that this arrangement will make the meeting more interesting to officers who attend it.

At the end of the meeting tea will be available for those officers who require it.

Further particulars will be published in the monthly *Supplements*.

4. R.E. Museum

The R.E. Museum at Brompton Barracks, Chatham, will be reopened, as soon as repairs to the building have been completed. We have received a number of interesting exhibits in connexion with the war. Lists of these items have been notified from time to time in the *Supplement*. In consequence of this the space available is rather cramped, but any expansion will have to await decisions regarding the future location of the Headquarters of the Corps.

5. Articles in this Issue of the "Journal"

Pegasus and the Wyvern is an interesting account of the part played by the Sappers of the 43rd Div. in the withdrawal of the remnants of the 1st Airborne Div. from Arnhem.

The article entitled *Sappers in Southern Latitudes* shows how ubiquitous has been the work of the Corps during the war. Few officers can have known of the fact that a sapper detachment went to the Antarctic Polar regions to reconnoitre the possibility of establishing a military installation there.

Operation Freshman gives some details of a failure which has not previously been reported in the press. A sapper airborne party proceeded to Norway in 1942 to destroy the German heavy-water plant at Rjuken. Owing to bad weather conditions both the gliders and one tug crashed. The personnel who were not killed were captured and shot by the Germans. The details of this story were collected after our return to Norway in 1945. It will be remembered that a later attempt was completely successful.

Other articles on episodes in the war include *A Railway Bridge over the Rhine*, *Reconstruction of Patenga Airfield*, *Aid to Russia*, *4th Indian Div. in Macedonia*, and *R.E. Work on the L. of C.* The last gives a good picture of the variety of work carried out and the conditions which affected this work in North-West Europe.

Twenty Years in the Development of Military Bridging gives a good summary of the great advances made in the design of bridges in this period and which made possible the advance of our armoured forces and our supply columns over hundreds of rivers in all theatres of the war.

J.E.E. has submitted more brief reviews of a number of new *War Books*.

Refrigeration of Food in the Army gives some details of a type of work of which few sapper officers have much experience, but which is likely to be of more importance in the future.

R.E. WORK ON THE L. OF C. WITH THE B.L.A.

By Brig. R. H. Perry, C.B.E., M.C.

Note.—This article was written in July, 1945, as part of a publication dealing with all aspects of L. of C. work. It is, therefore, non technical, its object being to give some idea in simple language of Royal Engineer activities on the L. of C.

The Construction of all Army Camps, Depots and Installations on the L. of C.

This is a brief description of how the Depots, Hospitals, Camps and other installations necessary to maintain the forward troops, were constructed by the Royal Engineers of the Lines of Communication.

There were two main tasks in this work ; establishment of the Rear Maintenance Area and the Advanced Base.

The Rear Maintenance Area was the name given to the original Normandy beachhead area where all these installations were first laid out.

The Advanced Base was an area centred about the ports of Antwerp and Ghent comprising the greater part of Northern Belgium, where these installations were set up anew and enlarged in order to maintain the armies during the winter campaign.

In addition to these two main tasks there was always a large volume of work on hand not directly connected with either, but nevertheless, of great importance and often involving the Royal Engineers in what can only be described as major undertakings.

The Establishment of the Rear Maintenance Area

This work was, of course, elaborately planned before the landing took place. It was realized that practically all the material required would have to be shipped across the Channel, and, for that reason, all installations were cut down to a minimum. It was also realized that a million men, together with all their supplies and equipment, were going to cause the greatest congestion in such a small area. Sites for depots that would have been rejected as unsuitable under any other circumstances had to be accepted, and the most careful organization was necessary to fit in everything that was required. Literally every field was occupied by some part of the British Army.

Depots

In all of these, covered accommodation was required to a greater or lesser extent. Some had lighting installations and many special fittings such as bins and racks.

In practically every case road access was the hardest problem to solve. It must be realized that the beachhead area was a quiet farming district with narrow winding country roads which were never intended to carry more than a few farm wagons. Most of the vehicles carrying stores in and out of these depots were ten-ton lorries.

It was foreseen that there would be great difficulties over this and a phased programme was drawn up for the gradual development of access roads, complete lay-out plans for all depots being prepared in the initial stages.

To begin with, the roads were made of earth, at the next stage tracked roads were laid, and later, as the quarries began to be developed, hard roads.

The largest of these depots was the Advanced Ordnance Depot, where 300 Semi-Romney huts were erected. Concrete paths were laid down the centre of each and the stores were handled by petrol engined trucks in the same way as the luggage in a London railway terminus.

Other depots set up included the Engineer Stores Base Depot, where all the engineer plant was stored, the Supplies Depots, where the food was stored, Oil and Petrol Depots, Ammunition Depots and many more.

Considerable difficulty was experienced with the ammunition depots. Ammunition is stacked, if possible, along the sides of existing roads, but well dispersed so that there is only 1,000 tons per mile of road. This meant, when the huge quantities required were taken into consideration, that sufficient roads just did not exist and it was physically impossible for R.E. to construct new ones for the occasion without abandoning all other work.

As a result, large quantities of ammunition were stacked deep into fields without roads and were later found to be unapproachable. In the winter its recovery was another major R.E. task.

A task that was not envisaged was the construction of trans-shipment points at which stores were loaded from " Dukws " on to ordinary lorries. The depots were some distance from the beaches and owing to the slow traffic circulation in the beachhead this was necessary in order to speed the " turn round " of the amphibious vehicles.

Camps and Hospitals

Certain general principles were laid down in England as to the extent of R.E. services that would be provided. Basically, they amounted to a bare minimum for hospitals and, with certain exceptions, nothing at all for camps.

Even a " bare minimum " of essential services for the hospitals was a very major undertaking. There were 28 of these all situated along the same road. They were provided with an austerity standard of what is known as " camp structures " which might be described as " usual offices " of rough but ingenious construction.

Roads and paths were laid as well as concrete floors in the special tents used as operating theatres. Initially, the water supply consisted of a limited number of draw-off points in each hospital, but later it was developed into a full distribution system, involving pumping stations, storage tanks, and much piping.

Sewage disposal was also gradually developed. Eventually, a full sullage disposal system was completed in many of the hospitals.

Neither the water supply nor the sewage disposal was developed to the final stage in every case before the battle moved on and the hospitals with it.

A plan had been agreed in England on the extent of these services to be provided, but it was soon found that officers commanding hospitals wanted more, and while the divergence of their views was remarkable, it was generally possible at least to provide some form of working appeasement.

Where you have hospitals you have laundries. Three Base Laundries were set up and they involved much work. Each required 200,000 gallons of water per day, all of which was drawn from the River La Drome, a tributary of the Seulles. As the only way of disposing of the waste water exuding from the laundries was to put it back into the Drome, it was necessary to provide a full sullage disposal system for each laundry before it could operate.

Camps, as such, were not at any time a serious problem. Bivouacs were the order of the day. Generally, the work resolved itself into little more than a bull-dozed field entrance with perhaps an earth or tracked road and occasionally an independent water supply, although more often than not it had to be drawn by water truck from one of the water points established throughout the area. The principle of self-help was accepted, and very few demands were made on the R.E.

A number of Institutes were erected quite early in the campaign and those in the hospital area had special provision for Nursing Sisters.

A large tented camp was erected for H.Q. 21 Army Group when they arrived, and also a small leave camp for forward troops.

The Advanced Base

Normandy is an agricultural area; the North of Belgium is one of the most highly industrialized areas in the world, containing two of the most important ports in Europe.

It is hardly surprising, therefore, that the problem facing the Royal Engineers in the construction of the Advanced Base was completely different from the problem in the beachhead.

The roads were generally good and wide. There was ample accommodation of every description and the people of Belgium were only too anxious to assist in every way possible.

The season, however, had changed. What would do in the orchards of Normandy in summer was not a possibility between the dykes of the Low Countries in winter.

The problem became a matter of adapting existing accommodation to the needs of modern armies fighting a winter campaign.

Depots

These were housed for the most part in a number of excellent factory buildings and very few huts of any sort were required in the initial stages. Good as these buildings were, however, they had not been designed to handle the volume or type of stores now to pass through them, and a very considerable amount of work was carried out in the construction of service roads, parking spaces, loading bays, offices, etc.

A great many Belgian civilians, working with the British Army by this time, presented yet another problem. Food in Belgium was, at that time, very short. Canteens for the civilian employees had, therefore, to be erected at all the larger depots, a work involving the usual paraphernalia associated with communal feeding, but a task not unfamiliar to the Royal Engineers.

The V1.'s and V2.'s began to arrive in quantity soon after the work was well under way. A great many of the buildings in the area were fitted, in accordance with the best modern practice, with continuous roof lights. It was neither desirable nor possible for work to continue under these and the majority had to be replaced with corrugated iron or any substitute material available. This, in turn, meant that work in the depots had to proceed by artificial light and that an army of electricians had to be provided in order to adapt the existing lighting systems to the requirements of the new tenants.

Nearly every installation in the Antwerp area suffered damage from the missiles, and some on several occasions. In many cases hutting had to be provided to replace accommodation lost.

At the height of this activity practically all available labour was employed to deal with the damage, and progress on the planned Advanced Base almost came to a standstill.

A further problem arose when, under thaw conditions, many of the pavé roads, the most common type of road in the North of Belgium, began to break up under the heavy traffic passing over them. This was successfully dealt with, but it was no easy task as it was essential that the heavy traffic to the port should continue all the time.

Yet another new commitment was the provision of electric lighting to the whole of the vast Port Area of Antwerp so that the work of unloading the ships could continue through the night.

A further problem dealt with was one of sanitation. In many of the buildings existing installations were not designed to deal with the numbers of people now to work in them. Very considerable extensions had to be carried out, involving a great deal of work, as all sanitary arrangements were made in accordance with British practice, which is far more exacting than that generally accepted in Belgium.

Again, the Advanced Ordnance Depot was the largest single undertaking. It was housed almost entirely in existing factory accommodation. The Engineer Base Stores Depot was well situated with good roads, rail and canal services all to hand. However, considerable work was necessary as the huge store sheds had been severely damaged by the R.A.F.

Two Base Ammunition Depots were established, each demanding 80 miles of roadway. One such area was found, but for the other a forest with only 40 miles of road was the best that could be discovered. Happily, there were many rides in the forest. By judicious use of these and the assistance given by a small road construction party permanently allotted to the task, no serious troubles developed.

Camps and Hospitals

Ample existing accommodation was found for hospitals, even though "austerity standards" had been abandoned. It consisted mostly of civilian hospitals, schools, and convents, all of which appear to be in plentiful supply in Belgium.

The question of getting stretchers to the upper floors of schools and convents sometimes presented some difficulty, and in one or two instances lifts had to be installed.

Much work was, however, necessary in bringing cooking and sanitary installations up to the required standards.

Accommodation for troops was also in abundance, but again increases were required in the cooking and sanitary arrangements.

Other Commitments

So far, only the work in the Rear Maintenance Area and the Advanced Base has been described. A great deal of work was in progress all the time in other parts of the liberated area, which, although tending to be similar in general aspect, was in no wise less in its magnitude or in the complexity of its problems.

The largest of these undertakings was the provision of accommodation for Prisoners of War. Ten large camps were erected, housing some 200,000 men, of which three were 40,000 to 60,000 men camps.

They were mostly tented camps, with hutting for certain administrative offices. While much of the work was done by the prisoners themselves, the stores had to be provided through Engineer channels and perimeter fencing and floodlighting was a considerable undertaking.

Leave starting for the B.L.A. in January, although extremely welcome on all sides, involved, for the Royal Engineers, one of the most rushed jobs of the whole campaign.

The only suitable site at Calais for a transit camp was a minefield which had to be cleared first of all. Eventually, accommodation in huts was provided for some 23,000 men. The work was carried out on a lavish scale as it was intended from the start to provide every amenity within reason so that men could arrive in the United Kingdom in the best possible fettle to enjoy their leave. It included a first-class club for troops, excellent restaurant facilities, cinemas, ample lounges, games rooms, shower baths, etc. In addition, the camp was provided with its own bakery and butchery, as well as accommodation for the female staff. All this, for a population the size of St. Albans, was erected and working in the space of five months.

At the same time, work was going on at Lille and Tourcoing nearby, where feeding points were established for troops on the way. At either of these high tea could be provided at half an hour's notice for 2,000.

In Brussels extensive "short" leave accommodation was arranged, and, in all the major towns, hostels and transit camps were opened. Much civilian labour was used, but it always meant a great deal of work for Engineer staffs.

There were many other tasks, such as factories and accommodation for troops all over Northern France and Belgium.

There is still one task worth recording. The Rear Maintenance Area was with us to the end, if in an ever diminishing scale. As winter came on the remaining two of its 28 hospitals were made into hutted hospitals on the full military scale with electric lighting, heating, hot water systems and all that is required.

The Advanced Ordnanced Depot, with its 300 semi-Romney huts, was converted into a permanent hutted establishment. Corrugated iron replaced the canvas covering, roads and paths were greatly extended, lighting installed and hutted accommodation was provided for the troops operating the depot.

It was a far cry from the "austerity standards" to the large electric power station and pumping plant that were erected for these installations.

Water Supply

In the beachhead area the supply of water was by no means easy as there were no large rivers, geological conditions, except in a few small areas, were bad for borehole wells, and there was no large town main supply on which to draw.

The water supply system for Bayeux was antiquated in the extreme: if one put on larger pumps to increase the supply the cast iron rising main burst and the wells dried up in a few hours.

Small portable water plants taking water from the streams, sterilizing it, and delivering to small storage tanks served the purpose sufficiently well till the advance into Belgium took place, but then more serious efforts had to be made to provide water for the static installations remaining behind.

The Caen water supply came from springs at Moulins about 15 miles from the city—the main had been damaged during the fighting in many places which could only be discovered one by one when the water was allowed to flow down the pipe. This took time, so, as an emergency matter, recourse was had to wells in the city. These, however, could not function as the Caen power house had been put out of action: engines from a stranded L.C.T. and a Valentine tank were therefore used to drive certain pumps, and so put a limited supply of water into those parts of Caen where there still remained some undamaged water mains.

For the permanent installations which remained in the beachhead area, after the advance, time was available to sink boreholes in a few cases, and to put in large pumping plants in suitable streams to deal with the considerable military population.

The coast towns of Dieppe, Calais and Boulogne when captured had no water supply, but within a few days a limited amount, later rising to the full scale previously available, was provided as soon as the damaged mains and pumping stations could be repaired.

The island of Walcheren suffered badly from water—too much on the land, and none in the pipe, as the supply came from the mainland across the dykes which were the scene of such bitter fighting for the capture of the island. Temporary repairs were made, and after a time the Town of Goes, on S. Beveland, had water from 9 a.m. till 9 p.m., and Middleburgh, on Walcheren, for the night.

For Prisoner of War camps the supply of water was an undertaking of considerable magnitude when it is considered that in certain cases a supply of nearly three quarters of a million gallons per day was necessary. Complete pumping stations, overhead storage tanks and distribution to cookhouses and ablution sheds were installed, and though the work was cut down to minimum essentials many villages and small towns in England would have welcomed such facilities.

Roads and Quarries

The repair and maintenance of roads was one of the L. of C. Sappers' most important tasks, involving work which at times assumed tremendous proportions.

In the beachhead, with literally thousands of vehicles continuously operating over a number of narrow, poorly made roads with bottle necks in every village, the work was intensive and concentrated.

It consisted largely of extensive widening of existing narrow roads to permit of safe two way traffic, surfacing of those roads which were good to prevent them breaking up under the strain, and the construction of by-passes and detours.

Widening and surfacing were at times a nightmare, traffic could not be stopped, and men worked to widen narrow roads using soft stone, which was all that was available, dodging lorries and choked with dust.

Many of the roads practically disintegrated before they could be tackled, but somehow they were patched up enough to keep traffic moving and gradually conditions improved, till, by the time the bulk of the Army moved on, the Caen-Bayeux road had been tar sprayed throughout its length and the main lateral from Bayeux to the Orne canal near Ouistreham had been widened to a 24 ft. carriageway.

The towns of Bayeux and Caen, and practically every village in Normandy, were bottle necks of the worst description. It was therefore necessary in many cases to construct detours and by-passes to avoid them. Initially these

were only bull-dozed tracks, later surfaced with Sommerfeld Track and Chespale. Some of major importance, however, were properly pitched with stone and surfaced.

The by-passes at Bayeux and Caen were examples of this and were major engineering works of tremendous value in preventing traffic stagnation, but their construction required a considerable amount of Mechanical Equipment and tied up a large number of the available sappers for a long time.

Roads in Depots and Installations were, in most cases, limited to track expedients. It was necessary in the case of the Engineer Stores Base Depot and Tn. Stores Depot for much permanent road work to be carried out, whilst the Advanced Ordnance Depot was completely laid out with permanent roads.

As the Armies overran France and Belgium, so a lengthy L. of C. developed setting the R.E. a considerable task in maintaining the main routes forward from the established installations in Normandy. Several hundreds of miles of road had to be kept up under intense traffic conditions, so that the numbers of Sappers and Tipper Lorries for the supply of materials became dangerously inadequate.

The existing civilian organizations were brought into use, but although labour was generally available, the transport situation became worse, as no civil transport was forthcoming and all materials had to be carried on our own vehicles. This seriously limited the civilian usefulness.

The final advance into Germany brought about another intensive road making effort, many R.E. Road Construction Coys. having to be sent forward to rebuild the roads which the operational movements in the Winter had in many places completely destroyed.

Right from the beginning of the campaign the provision of suitable road making materials was a major concern for the R.E.

In Normandy there were a number of quarries of soft stone which, whilst most unsuitable for road work, had of necessity to be used. No quarry machinery was found, but the R.E. Quarrying Units installed their own field equipments and quickly organized production on a large scale. As much as 15,000 tons a day was at one time taken out of the Creully Quarry.

The difficulty with this stone was its inability to resist abrasion under the heavy loads and there was an urgent demand for a harder stone for surfacing. This was partially met later from hard stone quarries at Perriers and Mouen when they were captured, but these were both comparatively small installations and, although R.E. repaired the existing derelict machinery and installed their own apparatus, the output was but a very small percentage of the actual requirements.

Later, adequate stone for the main routes was available from the Marquise Group of quarries near Boulogne, whence it was distributed by rail.

The Quarries at Lessines and Quenast served us well in Belgium, substantial stocks being held and the daily production being good. This was also generally distributed by both rail and canal.

The majority of the Tarmac used was produced by the Sappers own field Tarmac plants, but several small civilian plants in both France and Belgium were utilized.

The road problem in this campaign was more how to keep existing roads in a usable condition than to make new roads. There were periods of crisis when it looked as though some of the main routes would disintegrate before they could be saved, and it was with some astonishment one found that even inferior country roads could take an immense volume of traffic of a type for which they had not been designed, provided incipient disintegration was tackled in time.

Petrol Pipe Lines and Storage

The British Bulk Petrol system in N.W. Europe can be divided into two parts, the Western or Normandy system built in the Summer of 1944 extending from Cherbourg to Fougette (east of Rouen) a distance of 397 miles, with intakes at Cherbourg, Port-en-Bessin and Ouistreham, and secondly the Eastern system built in the Autumn of 1944 and Winter of 1944/45, extending from Boulogne to Bocholt a distance of 310 miles, with intakes at Boulogne (Dumbo) and Calais, Ostend and Antwerp by tank ships. This system is still operating and crosses parts of France, Belgium and Holland into Germany.

A Bulk Petrol system consists of three main essentials viz :—

(*a*) Importing facilities, which are either underchannel lines or facilities for unloading tank ships at ports. The unloading may be direct to storage tanks or to Balance tanks from which the petrol is boosted to storage tanks by low pressure, high capacity pumps.

(*b*) A series of high pressure pumping stations, each consisting of storage tanks, either Army built or reconditioned Civil Installations, high pressure pumps and 6 in. Victaulic lines forward to the next station.

(*c*) Filling points for Bulk Petrol Wagons, Rail Tank Cars, Barges and Jerricans which are established at suitable locations along the line.

In the above the R.A.S.C. determines the petrol demand, orders in the imports and decides where deliveries will be made. The R.A.S.C. do the receiving and accounting for all imports, and handle all distribution. They also operate low pressure installations.

The R.E. build all installations and operate and maintain all high pressure installations and lines.

Smooth operation of the system has resulted from the closest co-operation between R.E. and R.A.S.C., with mutual exchange of information and requirements at every level.

Planning before "D-Day" was carried out in 21 Army Group by the Works Directorate, and the S. & T. Directorate. These two departments co-operated very closely on locations and estimated demands.

Using large scale maps and aerial photographs, tentative routes for the pipelines and locations for the pump stations were chosen. The construction progress was estimated and materials listed and phased to arrive in the theatre when needed. Materials were phased by days up to "D"+ 90, with bulk reserves available, to be called forward after that.

These materials were pre-packed at Long Marston and marked for delivery by days. The stores for Port-en-Bessin eastwards were phased in at that port, while stores for Cherbourg to Port-en-Bessin were to arrive at Cherbourg.

Troops for construction and operation of the pipelines were trained in the Isle of Wight, in tank building, pump installation, pipe-laying, in Tombola sea lines and in operation.

Two Oil Groups were formed, one to start from Port-en-Bessin eastwards, the other to start from Cherbourg to Port-en-Bessin, then both groups would work on forward lines.

An Oil Group consists essentially of one C.R.E., one D.C.R.E., two Artisan Works Coys. R.E., one E. & M. Coy. R.E. with Type "A" and Type "B" E. & M. Pls., one Mech. Eqpt. Pl. R.E., one welding Pl. R.E., two Pioneer Corps Coys. and two Pls. G.T. Coy. R.A.S.C. Two other E. & M. Coys. were included for operating the line.

R.E. and R.A.S.C. personnel landed at Port-en-Bessin on " D-Day " and immediately started recce for tank and pump sites, choosing substantially the same locations as had been picked in the planning.

Stores, at first, came in on time : then the four day storm in June, plus four days with only ammunition coming in, disarranged all stores schedules.

Port-en-Bessin construction proceeded with dock unloading lines, sea lines, balance sites, main storage and bulk lorry loading. Deliveries from Port-en-Bessin started early in July.

At Port-en-Bessin there were jetty lines for us and the U.S.A. We also had two sea lines, or Tombolas, extending 3,000 feet out to 5 fathoms, and buoyed, so that larger tankers could unload. The Americans also had two sea lines a few miles West.

As Port-en-Bessin harbour dried out and was very small, ships were liable to ground on the bottom. There was also trouble with the sea lines as the tankers used to hang on too long in a rough sea and would pull the line and break it.

When the break-out from the beachhead took place the line was pushed on at high speed, in an endeavour to keep up with the advance, till the River Seine was crossed at Rouen and the terminal station of the Western System established at Fougette.

Each station, including Port-en-Bessin and eastwards to Rouen had bulk lorry loading facilities. Darnetal was a train filling and Fougette a can filling station. Cherbourg to Isigny inclusive were solely high pressure stations. Cherbourg received petrol from the U.S.A. installations.

Five undersea Pluto lines were brought in to Cherbourg but were not successful. The Cherbourg–Rouen line was handed over to the U.S.A. in January, 1945.

As Channel Ports were captured the second phase began, since it was evident that it would be better to supply direct to installations at the forward ports and lay pipelines on from them, rather than to continue the Normandy line.

Work was started in September, 1944 at Boulogne and Antwerp, the former town being the Continental end of under channel lines from Dungeness. These lines have been successful.

A triple 6 in. victaulic line was laid to Calais and was in operation in early December, 1944. Rail tank car and bulk lorry loading points disposed of M.T. Petrol at Calais. Boulogne also has bulk lorry filling. Calais has jetty lines for tankship imports.

At Antwerp existing civilian tankage was used and local facilities set up for train, barge and bulk lorry deliveries. Lines were also started forward towards Eindhoven. In November, 1944, tanker unloading facilities were installed at Ostend and a triple 6 in. line laid to Ghent where full distribution facilities were put in, using existing tankage.

In January, 1945, Calais was connected to Ghent with a new line. This was put into operation in March, 1945, and M.T. Petrol imports at Ostend discontinued.

In the month of April, 1945, Ghent was connected to Contich, the first station forward from Antwerp.

The line forward from Antwerp through Eindhoven reached Emmerich on the East Bank of the Rhine, whence it was extended to Bocholt.

Thus stage by stage the system was built up from Boulogne to Bocholt, enabling petrol to be pumped from England to Germany.

As soon as the line was extended one station east of Port-en-Bessin, R.E. operators started pumping petrol forward. An E. & M. Coy. R.E. took over each new station as it was constructed, keeping R.E. as operators and getting Pioneer Corps personnel for line patrols.

The whole western line was finally operated by a single unit, with a Central Control at Bayeux. There were difficulties, chiefly due to Signals which were bad, as the whole Signals system was overworked, and the local lines between stations frequently broke down.

The Boulogne–Bocholt line is similarly operated by E. & M. Coys. R.E., with both civilians and Pioneer Corps. Civilians are particularly good, as technicians can be obtained for the pump stations.

Trouble was experienced through heat expansion in April and May, 1945, especially of the pipes laid during the winter when the temperature was below freezing point for days at a time. This has been corrected by covering the pipeline with 4 in. of earth which prevents great temperature variations.

The lines operate for 24 hours per day, 7 days a week, and one E. & M. Pl. is now operating three pump stations with 40 to 50 civilians or Pioneers on each station. Originally one E. & M. Pl. with a strength of 58 operated one station and the 20 miles of pipeline to the next station.

2,750 tons per day has been maintained for a period through two 6 in. pipelines, but the long term average allowing for R.A.S.C. demands of varying requirements, line breaks, engine troubles, etc., seems to be a little over 1,000 tons per day per 6 in. pipeline.

Fire fighting apparatus, water and foam, is held at each pump station, but though fires have occurred none have been really serious and they were soon put out.

Breaks have been repaired in half an hour, but the usual time taken to find and repair a break is from two to four hours. The more valves in a pipeline the quicker the break can be isolated and repaired.

There was some trouble with pilfering near Mezidon on the Normandy line and on the Boulogne–Bocholt line the chief trouble was near Herenthals (Belgium), which is a centre of the " Black Market," where well organized gangs broke the line and did a fine trade in illicit petrol till dispersed by patrols.

Good signal communications are essential, and R. Signals have given splendid co-operation.

The pumping of Bulk M.T. petrol, and to a smaller extent aviation spirit, has proved a practical and successful operation in this theatre. There have been many difficulties and many lessons had to be learned from experience, but these will be available for any future operations.

The bulk petrol systems have pumped over 100 million ton/miles of petrol and this has resulted in an immense practical saving of road transport and personnel, to say nothing of the saving in road congestion during heavy movements of troops and supplies.

The Provision and Operation of Electric Generating Plant

Owing to Caen Power Station having been bombed out of action, it was necessary in the initial stages of the campaign to instal independent generating plant where electrical energy was required.

Several generating sets, ranging from small country house sets to large size generators, were installed in the Bayeux area to supply lighting to Field Hospital Operating Tents and to give power to factories and workshops engaged on essential military work, especially saw-mills and wood working shops.

An ice factory was also set to work by connecting up a trailer-mounted generating set to the ice making equipment, thus enabling ice to be supplied to the tented military hospitals set up in the beachhead.

Seven rail-mounted power stations, each capable of lighting a small town, were available where the demand justified their use.

Three of these mobile power stations, complete with necessary cable, and accommodation for operating crews, were shunted to a siding near the Caen Power Station and a supply made available to the Caen Docks for working the cranes and other dock equipment.

The E. and M. Coy., R.E., while operating these rail-mounted sets, also began work in the Caen power station.

Close inspection showed that two turbo-alternators could be put into commission at reduced load if the damaged parts were replaced by parts taken from other turbo-alternators damaged beyond immediate repair. The boilers and auxiliaries were found to be capable of raising steam to meet this reduced load after replacements had been effected and a complete over-haul of the steam mains.

By systematic cannibalization of high tension switchgear, sufficient apparatus was obtained to build suitable control panels for this plant.

There was no roof to the power house, and very little remained of the walls except the steel framing. The day steam was turned on to the first repaired turbine provided quite a thrill as it was the first large installation to be restarted after " D-Day."

When the steam valves were opened clouds of steam came out of the main pipes from many unauthorized places, but gradually the turbine began to turn, slowly working up speed as the throttle was opened till about 1,000 revs. per minute had been reached.

At this point horrible expensive noises came from the interior of the turbine. Steam was hastily shut off, and when the machine had come to rest it was examined anxiously. No apparent damage had been done, so the R.E. officer in charge decided to try again in the afternoon.

Speed was again slowly built up, with everyone on the alert for any unusual noise, but nothing untoward occurred, and the turbine reached its normal running speed without mishap.

The first large damaged electrical installation in France had been made to work amid the wreckage all around.

The lack of roof and walls was a sore handicap which was demonstrated one rainy day when suddenly the whole power house became " live " through leaks caused by the rain. The antics of a cat on hot bricks were as nothing compared to those of the engineer staff till the switches were pulled out. Indents for rubber boots followed this episode, marked " Red Hot "—a suitable degree of priority!

The High Tension line from Caen to Bayeux, although extensively damaged, was again rebuilt and power transmitted to Bayeux.

The remaining rail-mounted power stations were formed into a " power train " and held as a standby for the Antwerp Dock area, should the public supply fail, due to enemy action. This " power train " was complete with all switch gear, transformers, rectifying equipment and apparatus needed to operate the complicated lock gates, cranes, pumps, etc., of this extensive port.

Independent generating plants were installed at the stone quarries at Mouen and Perriers, thus enabling the electrical stone crushing machinery to be put into action.

Two ships specially built as power stations, over 300 feet in length and equipped with turbo-alternators of 30,000 kilowatts capacity, were brought into the theatre in the Autumn of 1944, and were connected to the Belgian Grid System at Antwerp and Ghent, thus relieving the respective stations of a corresponding amount of load, which, in time, effected an appreciable saving in coal consumption during an acute shortage.

After the phasing in of the floating power station at Antwerp, the Royal Engineers undertook the construction of a new high tension line from Belgium into Holland after the destruction of the Gertruidenberg power station in Holland.

This project was carried out under most dangerous conditions in appalling weather, through snow, marshy country and minefields.

Two days after the two transformers of 12,500 K.V.A. capacity were installed at Gertruidenberg they sustained damage by enemy action when the power station was again shelled. The Sappers at once tackled the job and effected repairs, thus completing the largest scheme of its kind undertaken by the Army in this theatre.

Bridging

Engineers are always associated with bridges in the army more than with anything else. Construction of these is not confined entirely to the forward troops, though usually they are the ones who gain mention in the newspapers.

As the armies move forward, so they leave behind bridges which are taken over by the Lines of Communication troops who move in behind the army.

Normally L. of C. troops do not construct many bridges of the " Meccano" type, but often they take these down and construct improvised steel and timber bridges in their place.

In the campaign of the autumn of 1944, when 21 A. Gp. broke out of their bridgehead and moved rapidly forward through France and Belgium, it seemed possible that the forward troops would become short of bridging equipment. An S.O.S. was therefore sent out for the maximum number of bridges in the L. of C., which were not required, to be taken down and sent forward with all possible speed.

Accordingly as many troops as possible commenced dismantling Bailey bridges and transport was produced to get them forward.

The bridges taken down at first were those where no replacement was necessary. Many of these were not on roads, but had been put across rivers or canals in any convenient place in order to get the tanks across. Later, when the main crisis was over, it was decided to take down further bridges, where replacements could be easily erected. In some cases these were constructed by the R.E. and in others by the National Civilian Authorities. In the latter case, especially in the early days, considerable assistance was required from army resources in transport and materials.

Bridging in the L. of C. is not usually spectacular, but is very necessary if the maintenance routes for the armies are to be kept open.

In this theatre, great difficulty was often experienced in finding the necessary stores, particularly steel joists. Difficulties were, however, overcome, and no essential traffic was held up for want of a bridge.

Requisitioned Buildings

As soon as the Armies broke out of the beachhead and L. of C. formations and units took up more or less static positions in the extended L. of C. area, there was a tremendous demand for accommodation of a type superior to the bivouacs which generally sufficed in Normandy. Tentage was not available, and the immediate erection of hutting was not possible. Resort was therefore made to the requisitioning of civilian premises which brought forth a continuous crop of urgent demands for alteration and repair works requiring the services of skilled artisans.

In the larger towns where civilian labour was available, the local authorities were co-opted and much of the work was carried out directly by that authority as a charge against Mutual Aid, utilizing civilian labour, and often with local materials. Where materials could not be found locally these were supplied from one or other of the R.E. dumps.

Apart from the fitting of black-outs and the execution of immediate first aid repairs to many of the premises taken over, the works generally included the provision of increased sanitary and water supply services and electric light, the installation of centralized cooking and dining facilities, centralized bath-houses, access roads and hard standings for vehicles.

In their hurried retreat the Germans found enough time when evacuating the coastal towns of Belgium to cut and remove practically all water and sewage pipes in the hotels and large houses, and smash all wash basins, lavatory pans and fittings, a childish passion for destruction which did, however, cause a very considerable amount of plumbing work for our limited resources in this trade.

Engineer Intelligence

It was not at first realized that Engineer Intelligence would be any great asset to the L. of C. Engineer organization and, it was only towards the end of August, 1944, that a small beginning was made by an officer and a staff sergeant in a passage in an old chateau near Bayeux in the Normandy beach-head. As the lines of communication grew " Int " became a substantial part of the Chief Engineer's headquarters.

Much work on Engineer Intelligence was being done by other head-quarters, particularly SHAEF and 21 Army Group, but it was primarily for the use of forward troops. It was very soon discovered that many of the problems of the Royal Engineer units working on the L. of C. remained unsolved, until they reached the place where they were to operate and were able to find out for themselves only after valuable time had been lost.

They wanted to know much that was of little interest to forward troops, such as the detail of how the roads were built in the different countries, how the electric power was generated and distributed, how the sewage was disposed of in the larger towns, where to get stone (by the train-load), and many other things besides so often taken for granted in normal life, but of great intricacy in their detail.

Where to get all this information was a problem solved only after much trial and error. At the end of it a collection of technical documents presented itself in a bewildering variety of languages. Most happily by this time a Belgian officer speaking no less than nine languages was attached to the staff. His services we employed to the full. Translations were made from French, Flemish, Dutch, German, Danish, Polish, Czech and American, but unfortunately no great use could be made of his fluent Gaelic !

Very elaborate records were kept of the supply routes and always alternatives had to be borne in mind in case something went wrong. Details were collected of some 6,000 bridges and if trouble did arise on one of the routes, it was possible to give an alternative, generally in the space of half an hour at the most. Some seven hundred Bailey bridges that had been constructed by forward troops were taken down and the parts sent up to the forward areas for re-erection. Improvised bridges were sometimes built to replace them. Bridges hastily constructed over canals often blocked the canal traffic. They had to be raised or taken away as soon as it was possible to work the canals again. A few old bridges of the country began to tire under the constant stream of heavy military traffic, and new limits had to be set for the loads that could pass over them.

All this constant change was recorded. On several occasions reports of over a hundred bridges were received in one day, but the record was seldom more than two or three days behind the latest report.

Minefields were also recorded. Until an attempt to make a record of these is begun it is hard to realize what vast areas of the continent have been mined. There were some 1,500 minefields recorded West of the Seine. There are reported to be four million mines in Holland and, judging by present progress in the work of recording them, there is no reason to believe that the estimate is anything but conservative. The work is monotonous and all the time it is necessary to bear in mind that the slightest inaccuracy may well cause the loss of several lives.

After the records were completed, copies were handed over to the nationals concerned and, so far as operations would permit, every possible assistance was given to help them in the formidable task of clearance.

Frequent conferences were held with these Allied officers and very close co-operation was established on the most friendly basis.

Other records were also maintained. These included one of the petrol pipe lines and installations which start in England and end in Germany. It showed exactly where the line was laid and how much progress had been made to date.

Another was of electric power lines, and another of the many anti-aircraft gun sites that were erected for the defence of Antwerp.

That is a brief description of the activities undertaken by L. of C. Engineer Intelligence, which started from such small beginnings.

It is perhaps worth noting that Engineer Intelligence as such is a very new addition to the work of the Royal Engineers. Since 1940 its growth has been prolific, and this branch of it is its most recent development.

Man Power and the Time Factor

At all times there has been a tremendous shortage of Engineer troops, which was aggravated by the extreme urgency of all works, and the importance attributed by all Services to works in which they were primarily interested.

Target dates set for even major engineering tasks indicated an unswerving faith in the Sappers' abilities, which, while flattering in the extreme, proved intensely difficult to live up to.

Nevertheless, some good times were accomplished, a few details of which are shown below for large, medium, and small rush jobs.

Calais.	Hutted Camps to sleep and feed 8,000 all ranks and to provide Dining and Resting Accn. for an additional 8,000, complete with all Services, Roads, Regtl. Institutes, Theatres and Cinemas, were erected on the site of a German Minefield.	5 R.E. Coys. and 4 Pioneer Coys. in 5 weeks.
Kraai.	A Prisoner of War Camp, on tented basis, for 10,000, but with all Services laid on to cope with 15,000, including also a Hutted C.R.S., and various other hutted buildings, roads, perimeter wire and lighting and independent water supply.	1 R.E. Coy. in 6 weeks.
Naeken. (Brussels)	A complete hot and cold shower bath system, with 76 points installed and tested in an existing building. To avoid cutting and screwing of pipes, the whole installation was welded involving over 300 cuts and welded joints to 3 in. pipe.	E. & M. Platoon of an Army Tps. Coy. in 48 hours.

The Use of Civil Labour and Mutual Aid

The assistance given to the Royal Engineers by Civil Labour has varied greatly in the Countries occupied.

In Normandy civil labour has never been available, although latterly the local authority has helped in maintaining the roads and bridges.

In the remainder of France, civil assistance has varied extensively, the greatest help being obtained in the large undamaged towns, whereas in the country districts the civilian effort has been negligible.

Throughout Belgium, the greatest possible assistance has at all times been forthcoming, the majority of the work to requisitioned premises being carried out exclusively by civil labour and very good labour it is too.

With the introduction of Mutual Aid in France and Belgium, the usual procedure followed was to demand on the local authority for any works required to be carried out. Sufficient details were provided by the Royal Engineers for the local engineers to arrange contracts if they so desired, the method of carrying out the works being left entirely to them.

Some works they executed by their own directly employed staff, but generally work was submitted to competitive tender, involving some delay.

In cases where the urgency of the works would not permit of this, civilian labour was directly employed under the Royal Engineers, the direction and supervision being furnished by the D.C's. R.E. and Officers of the Engineer Coys.

At one time the Artisan Works Coys. employed in the Antwerp area each employed up to 400 civilians, thus trebling their strength.

Similar assistance was given in Holland, although the number of civilians available was limited.

Mechanical Equipment

Mechanical plant of all types was extensively used in L. of C. by Mechanical Equipment Companies, Army Troops Companies, Road Construction Companies and Forestry Companies R.E.

Apart from those Engineer units with Mech. Eqpt. on their W.E. all other R.E. units were dependent on obtaining plant and assistance from the former or of drawing Pool Plant from the Works Directorate. At an early stage there were available excavators, tractors, both with all equipments, motor graders, dumpers, road rollers, stone crushers and screens, portable stone crushing plants, tar boilers, tar macadam mixers, portable tar macadam plants, portable air compressors, concrete mixers, colloidal mixers and agricultural tractors. Extensive use was made of this pool plant to augment unit holdings, and to adjust the pool held by the Chief Engineer L. of C. to meet changing circumstances and conditions.

Before the invasion of N.W. Europe was launched certain units were earmarked for special roles, and were specially equipped with plant suitable for the work contemplated. A special detachment was provided and trained by a Mech. Eqpt. Coy. R.E., in conjunction with Tn., to bring over and operate mobile and lorry mounted cranes for the unloading of stores on the beachhead landed by "Dukws." This unit was responsible for the Arromanches area and worked 24 hours a day until "D" + 60, when they handed over to a R.A.S.C. Operating Company whose men they had trained. The chief difficulty experienced was in repairing the cranes and keeping the largest possible percentage at work with very few spares or replacement parts.

Another Mech. Eqpt. Platoon was detached about a month before " D-Day " to operate Mechanical Equipment with the two Oil Groups, one half platoon landing in the U.S. Army area and the other at Port-en-Bessin. Their role was to excavate all road crossings, and to remove all obstructions to pipe laying and tank building, but in addition it was found that reinforced with a few extra excavators, equipped as cranes, that they were invaluable for unloading and re-loading stores and pumps and at tank sites and pump stations. Their heavy transport, primarily for moving their heavy plant, was in great demand for transporting oil tanks, pumps and engines.

Another special operation had to be carried out twice for the Royal Corps of Signals, the burying of the signal cables forward after the advance to the Seine, and again to Hamburg after the crossing of the Rhine. Some experience had been gained in Kent and Sussex in 1943 in laying ring cables to advance landing grounds, and some assistance was given in the Bayeux–Caen area before the fall of Caen. The first operation was performed by a platoon, reinforced with additional ditching ploughs, trench excavators, and tractors from other pls., and the second by another platoon, who mainly depended on ditchers and tractors.

In general the work in L. of C. requiring mechanical plant fell into phases, the first, after the preliminary landing, being the provision of temporary roads for M.T. and tracked vehicles and for dumps. Motor graders were the ideal machines for this work and a heavy call was made on pool, the heavier work being performed by tractor towed graders, scrapers and angle-dozers.

The second phase was the construction of the Bayeux and Caen by-passes where 75 per cent of the plant employed was found by L. of C. Mech. Eqpt. Units, and the same type of plant was in demand. By this time road repairs and widenings were of high priority and Quarries were being worked at great pressure, the larger ones by Quarrying Coys. and the smaller by Road Construction Coys. with their own plant, reinforced by 5 and 10 ton-per-hr. crushers from pool. Invaluable assistance was given by Mech. Eqpt. Units to the Quarrying Coys. in clearing overburden and providing excavators to assist with the loading of vehicles.

The third phase was the construction of semi-permanent installations, which called for concrete floors, winterized roads and drainage, providing work for Road Const. Coys., Mech. Eqpt. Coys. and Quarrying Coys. with all varieties of plant, and large demands had to be made on pool for concrete mixers, road rollers and dumpers, and excavators.

When bad weather set in, all withdrawals from dumps began to give trouble, the earth roads becoming impassable and the casualties to vehicles began to mount. Tractors were called in and sledges improvised, on which stores could be winched to hard roads, and the forward movement of stores continued. The Mech. Eqpt. Coy. left behind in the R.M.A. after the forward move, cleared several demolished bridges from out of the River Orne, which were causing flooding, salvaged a German " R " Boat from the Caen Canal, in whose engines the Royal Navy were very interested, and replaced and made rail-worthy railway wagons that had been run over the broken end of a bridge.

With the advance to the Seine fresh problems were encountered, and the Road Const. Coys. found their task was to maintain the main traffic routes congested with heavy traffic. Road rollers and tar boilers were the chief demand and agricultural tractors were required to tow the tar boilers. The repair of potholes assumed first priority and the roads of Normandy were lined with empty tar barrels.

Once the Seine was crossed, the rapid advance to Belgium and Holland found the Quarrying Group in possession of the Quenast quarries with ample stocks of broken stone, but no real loading facilities. In a short time 20 excavators were at work assisted by a few tractors and stone was being despatched by road, rail and water to all parts of Northern France, Belgium and Holland. A Mech. Eqpt. Pl. was an early arrival in Antwerp to assist in the construction of the port installations but soon found that it had an important P.A.D. role to perform, in connexion with the V-bomb attack.

By this time Ostend had become important and one Mech. Eqpt. Coy. with its platoons found itself employed on extensive road repairs, general works, and in recovering beach poles and obstacles to keep the manufacturer of huts supplied with timber.

The construction of the big Prisoner of War Camp at Zedelgem called for large quantities of plant and machinery, dumpers, agricultural tractors, concrete mixers, road rollers and tar macadam plant being all employed, while tractors and motor graders worked on the road formations. As this old Belgian Ordnance Depot had been completely rail served, roads had to be made to enable work to start.

The decision to make Calais the main leave port made further demands on the plant pool, the sites had to be cleared of rubble by angle-dozers, and concrete mixers and road rollers were required in quantity. The Road Const. Coy. engaged here found itself with more than double their normal quantity of plant to man and service.

During this period three Road Const. Coys. were busily engaged in the maintenance of all routes from the Seine to Belgium, and when snow arrived in early January assistance had to be given with motor graders and tractors to keep the airfields near Douai and Cambrai in operation. Winter storms caused the collapse of a sea bank on the Dutch Island of South Beveland, and Mech. Eqpt. excavators and tractors assisted the Dutch to raise the safety banks and confine the flooding to one area.

The chief demand, subsequent to the liberation of France and Belgium, was for excavators, in particular excavators rigged as cranes for handling stores, many platoons operating at least twice their establishment of these machines.

During the whole operation the heavy transport provided for all units equipped with Mechanical Equipment Plant was in great demand, the drivers standing up to the strain magnificently. On arrival in B.L.A. very few units were equipped to scale and all available low loaders had to be mustered to get their heavy equipment clear of the beaches. In addition, plant from U.K. was arriving for the Base Plant Park, and owing to the road congestion movement of heavy vehicles was restricted to 8 hours at night. With their heavy vehicles, Mech. Eqpt. Units in L. of C. tackled this commitment successfully, in addition to helping Quarrying and Road Const. Coys. to get installed.

With the opening of the Schelde for shipping, Mech. Eqpt., and Machinery literally poured on to the Antwerp quays, and a Mech. Eqpt. Pl. was called on to assist with the unloading and servicing of the plant. At the receiving end at Vilvorde a Mech. Eqpt. Park Coy. had been made available, and for more than 6 weeks heavy plant poured in, the unloading and storing proceeding throughout the 24 hrs. At the same time, machines were being assembled and despatched to Army and L. of C., and the company were performing the normal duties of a Base Plant Park.

Mechanical equipment of all sorts has amply proved itself in the L. of C. during this campaign.

Transport

The Transport available from R.E. Coys. for work as apart from domestic duties, was found to be inadequate for the operation in this theatre. The large amount of road construction and repair work that was necessary, especially in Normandy, and the extensive works in docks, installations, etc., right through the campaign made it necessary for C's R.E. to be allotted extra transport in the form of R.A.S.C. Tipper Coys. and G.T. Coys.

R.E. unit Tippers proved to be quite inadequate to cope with demands and 3 Tipper Coys., each of 120 vehicles, were allotted to the C.E. L. of C. for sub-allotment down to C's R.E. In the early stages these Tippers were carting mainly from quarries worked by R.E. Quarrying Coys., but some carting was done from gravel pits, etc., worked by C's R.E.

Congestion at the quarries and gravel pits was very bad in the early stages, and to relieve this more quarries were opened up so that by the end of September the position was much improved.

In August, to facilitate working, it was decided to place the Tipper Coys. under one C.R.A.S.C., and subsequently all R.A.S.C. Transport employed by the C.E. was placed under this C.R.A.S.C.

The G.T. Coys. did not come into the picture until the breakthrough into Belgium. One G.T. Coy. had always been allotted to the C.R.E. responsible for the petrol pipe-line, but it was not until later that this C.R.E. came under the C.E. L. of C. In all 4 G.T. Coys. had been allotted to the C.E. each of 120 vehicles of either 6 ton or 10 ton capacity.

Better results would probably have been obtained if these G.T. Coys. could have been worked from the E.S.B.D.'s—carting forward from the Depot to the C's R.E. as required, and as stores were available, but this was thought to be not practical because so many C'sR.E. were drawing stores from captured enemy dumps and civilian sources, and for this reason required extra transport under their direct control.

One of the main difficulties encountered was the split up of R.A.S.C. Platoons. The set-up of an R.A.S.C. Coy. allows for platoons to work away from their Coy. H.Q., each platoon being self supporting and able to fend for itself. Under the sub-allotment however, C's R.E. would often require a platoon to be divided between many points—two vehicles sometimes being detached away from platoon H.Q. for weeks. The difficulties encountered by the Platoon Officer, with his vehicles at 6 different places separated by 40 to 50 miles, can be imagined, and it speaks well for all concerned that the daily maintenance of vehicles was so good.

The idea of a mixed transport column being employed to work for another arm of the service was probably new, and it can be imagined that there were many difficulties—all of a minor nature—which were successfully overcome, added to that there was the large area covered. At one stage 32 Tpt. Column stretched from Caen to east of Brussels. In spite of all these things it is claimed that the idea was a complete success, and the amount of work performed by the Transport Column, was in excess of that which would have been performed by a similar number of vehicles not under one control.

Engineer Store Base Depots and Engineer Base Workshops

These establishments, which have always been located in the L. of C. area, have at all times been controlled by 21 Army Group.

The issues of operational stores from the Engineer Store Base Depots were controlled by the Chief Engineer 21 Army Group, whilst the Director of Works kept a watchful eye on all other items.

The Store Depots, which attained tremendous proportions, handled some amazing quantities of stores. From D. to V.E. day over three quarters of a million tons of assorted Engineer stores passed through them. A daily average of 2,000 tons was handled over the whole period, with a record figure of 4,000 tons being achieved on one day.

The Bridging stores alone involved the handling of over 100,000 tons, and the tonnage of Airfield Construction stores passed through exceeded that figure. The oil pipe line was another major commitment involving no less than 76,000 tons.

The production facilities of the Engineer base workshops—the variety of the work done was endless—were also controlled by the Director of Works.

An idea of the size of their operations may be gauged from the fact that the permanent bridges over the Rhine involved the production by the Engineer base workshops of over a quarter of a million separate items.

In addition, no fewer than 16,000 signboards of various sizes were constructed, over 1,000 pieces of R.E. Machinery completely overhauled and 2,000 waterproofed and cased for movement. The Machinery Spare Parts section of the Engineer base workshops handled over 18,000 separate demands in 6 months involving 288,000 items.

Work Not Normally Coming Within the Scope of R.E. Activities

Many peculiar jobs have been carried out by R.E. in this theatre mainly on the grounds that it was difficult to see which other service could have dealt with them.

These have ranged from the rescue of tanks and Ordnance recovery vehicles from the mud of Normandy to the removal and safe interment of a couple of dead elephants and a rhinoceros in Holland.

One demand, which was firmly rejected, was that we should become responsible for sharpening all knives on the L. of C.; another from the Czech Armoured Brigade was for a quantity of sacramental wine.

Although fully conscious of our ability to produce water from the desert, or any other unlikely place, we doubted our powers of turning it into wine, and had to enlist the aid of the Chaplain's department in overcoming this problem.

The de-flooding of the island of Walcheren, though under executive control of the Dutch Government, could not have succeeded without Royal Engineer assistance in men and plant. This however, is another story, which it is hoped will be dealt with fully at a later date, as the engineering problems solved were varied and considerable.

In conclusion it can be claimed that the Royal Engineers on the L. of C., though not enjoying some of the more spectacular triumphs of more forward units, did make a solid contribution to the success of the campaign in N.W. Europe.

PEGASUS AND THE WYVERN

(The Evacuation of the 1st Airborne Division from Arnhem)

Anonymous

MANY know the Airborne sign—Bellerophon mounted on the winged horse Pegasus. Many also know the Wyvern of Wessex—the yellow dragon with a knot in his tail—which is the sign of the 43rd (Wessex) Infantry Division. Both signs date back to early mythology. This is the story of their coming together on the banks of the lower Rhine at Arnhem.

Shorn of all complications the position was this. The 1st Airborne Division was on the north bank of the river hemmed in by superior forces of Germans, short of food, short of ammunition, and having suffered heavy casualties. The men had little left but the morale and discipline that is expected of men who have the honour to wear the Pegasus sign.

South of the river were the forward elements of the 43rd Division and 8th Armoured Brigade, a combination that had fought in the gruelling battles of the lodgement area in Normandy, had captured Mont Pinçon and forced the Seine. But it was terribly extended. Its tail stretched back across the Maas and the Waal, each spanned by great bridges captured by American airborne troops and the Guards Armoured Division. Vast distances separated the forward troops from their supplies of ammunition, food and maintenance areas. And the last lap lay across what came to be known as "The Island." The Island is a flat alluvial plain between the Waal and the Lower Rhine, a plain of small boggy fields and orchards, and roads on dykes with deep ditches on either side. It is entirely overlooked by the high wooded slopes about Arnhem on the north bank of the river. Movement by day was precarious, and by night the bad roads made it slow and laborious. The difficulties were aggravated by the Germans who also had a foothold on the Island from across the bridge at Arnhem and by the ferries to the east. Their foothold was a sure one, for they had the heaviest tanks and plenty of guns and ammunition from their bases in north Holland. Life on the Island was not fun.

Certain officers came across the Lower Rhine from the Airborne Division and explained in no uncertain way the conditions across the river. It boiled down to this: that unless the Airborne Division was either reinforced or withdrawn it could not but disintegrate in course of time, perhaps twenty-four hours, perhaps forty-eight hours or at the most seventy-two hours. A more hopeless state of affairs could hardly be pictured, for simultaneously the long L. of C. behind the 43rd Division was cut by a German battle group at Vegel. But the unbending will of commanders and the valour of the troops rose superior to it all.

First, it was decided to send a battalion (4th Dorsets) across the river to the aid of the Airborne Division. They were to take with them food and ammunition and were to form a firm base behind which the withdrawal was to take place. The assault boats for their crossing were to be assembled in an orchard on the river bank, a terrific bombardment was to cover the crossing and all was timed to start at 11.30 p.m. that night.

But war works like a vast machine against incredible friction. Combinations and plans that on paper appear simple can only be brought about by tremendous effort. All kinds of imponderable factors impose stresses upon it out of all proportion to their size.

The first misfortune was to the assault boats. Two lorry loads of these took a wrong turning after crossing the Nijmegen bridge on to the Island and motored straight into the Germans at Elst. Next the weather broke, clouds turned the evening into premature night and the drizzle turned the roads into a slippery rink, off which slithered two more loads of boats into the dykes on each side. By great exertion more boats were fetched across the fields on the carriers of another battalion. Men carrying them slid and fell into the mud. The enemy became aware of the attempt and mortared and shelled the Dorsets' forming-up area and their crossing did not finally take place until the small hours of the next morning.

By mere chance I found myself crouching on the start line next to the Commanding Officer of the Dorsets. All his arrangements had been perfect, tapes were laid to guide the men, and everything was ready, but there were no boats. At last they arrived and it seemed that he and his men were bound to go to certain death. From any other man one might have expected some acrimonious comment on the shortcomings of what was done for him. But no such word did he say. His final words were " Good-bye. Tell the Brigade that everything is O.K. and thank them for what they have done." It is to such men as this that England owes her greatness.*

On the river bank Sappers took the boats and rowed men and supplies across. It was pitch dark. On the far bank were two burning factories illuminating a rising forest of trees that went up from the water's edge. The swirling current drifted the boats downstream on the crossing and further downstream on the way back. Men wading in mud and water dragged them back along the water's edge for more trips. The mortar fire eased up a bit but was replaced by automatic fire. Someone had launched a " dukw," or amphibious lorry, at the ferry site about 200 yards upstream. As this swirled down across our front a Spandau opened up on it. The man on my right—a sapper corporal—was shot through the head and another on my left got a bullet through his arm. The ferrying went on until daylight. It was a bad night.

The next night the evacuation of the whole force took place. The site selected was about a mile upstream of the Dorset crossing place. Four field companies were to do the job, two of the Royal Canadian Engineers and two of the 43rd Division. About three miles downstream a feint was made in the afternoon and evening. A brigade with pontoons and bridge lorries performed all the evolutions as if for a crossing in force. The mass of impediments on the roads was a conspicuous target and certainly distracted the attention of the enemy from the main effort.

The evacuation itself was covered by every weapon that could be brought to bear—artillery, M.G.s, Brens, and, perhaps the most effective of all, the "Besa " fire of tanks. These and riflemen on the dyke that retains the river in time of flood opened fire on any flash on the far bank. If ever a Bosche loosed off a shot a fearful concentration of fire bespattered the ground about him. He was quick to perceive that there was no future in firing and lay doggo.

At about four o'clock in the afternoon I had explained the plot to the sapper officers, with instructions to tell their men. I could see from their faces that no one had any doubts about the unpleasant prospects. But they were stouthearted chaps ; the plan was so simple and the object so desirable that I had no qualms myself as to the outcome. It is a curious thing that in a straight fight with the Germans we always win. In the Dunkirk evacuation, in the Battle of Britain, in the invasion of Egypt, when the issue was perfectly

* An account of the Dorsets' magnificent fight across the river appeared in many London daily newspapers on 14th November, 1944.

clear to every man on both sides, the balance of armament in favour of the enemy could not prevent our succeeding. And here was a straight issue. We intended to evacuate the Airborne Division. The Germans intended to stop us. Moreover, the odds were not against us. The deception plan that I have mentioned made the odds even, and our divisional fire plan put the odds on our side.

Nevertheless, there were quite formidable difficulties. A small bridge had to be built to get the boats to the assembly area, no movement could begin till dusk when the narrow roads alone presented difficulties and the darkness made it quite impossible to exercise any control when once the operation had started.

As usual, it started to rain, and it was a dark night. The din of our own fire was terrific. From the forward assembly area to the river was a distance of about three hundred yards, over two high embankment dykes and across some mud flats. The river itself did not look inviting ; the current was swift and the water black and deep. The far bank was out of sight. Away to the left the factory by the Dorset crossing place was still burning.

The Canadians had " storm boats " ; the men of Wessex had " assault boats." Storm boats are made of wood and are flat like a punt, with an outboard motor. Assault boats are made of canvas, are collapsible and are rowed by men with paddles. It was clear that the canvas assault boats could be launched more easily than the storm boats, but that once the latter got going they would have a much better performance.

And so it worked out. The first assault boats, led by a sapper subaltern, pushed off into the stream at 9.15 p.m. For a long time nothing happened. I paced the shore like a cat on hot bricks oppressed by the most gloomy forebodings. Had they upset the boats and all gone silently to the bottom, weighed down by steel helmets and rifles ? Had they rowed straight into the waiting Hun on the far bank ? Or had they merely been washed downstream to God knows where ? It was a tense interval. But in battles the worst occurs as seldom as the best. Across the dark waters came the sound of dipping oars. Then I saw a boat. It held about a dozen men. I could see airborne pattern helmets. Never was there a more welcome sight. First one boat, then another, then another. About a hundred men came silently ashore with a few wounded. The boats stole back into the night.

The bearing and demeanour of these men were first class. Whether reaction set in afterwards and these splendid soldiers later presented a less soldierlike appearance I do not know. Maybe, but they were all right on the night.

More boats and more were launched and then I heard the motors of the Canadian storm boats start. No music could have seemed more sweet. Tapes on the mud flats and tracer from the A.A. guns firing horizontally marked the direction. Soon there was a steady stream of men filing back along the tapes. As they arrived the doctors and the " Q " department fell upon them, ministering to their needs. The machine was working.

By the small hours of the morning the current had quickened and made the rowing of assault boats almost impossible. But the Canadian storm boats continued with unabated zest. If the assault boats got the first hauls, the storm boats certainly got the greater ones.

As the dawn broke grey the troubles began. There was no flash to advertise the Bosche shooting. He became impertinent and interfered more. Each trip became more hazardous. Little fountains marked where mortar bombs had struck the water, debris of boats and struggling men marked the hits. But no one faltered. The crews of the assault boats were increased from four to six and then to eight to cope with the swifter stream The Canadians plied their ferries as if on the waters of their own great lakes and rivers.

Our gunners started firing smoke shells to screen the operation. At first this had a good effect. I believe the Germans thought it was gas. Soon, however, they found it wasn't and, becoming more adventurous, they set up their M.G.'s on the water's edge amongst the reeds and skimmed the surface of the water with automatic fire.

There were still some hundred men on the far bank, but our casualties were increasing. A young Canadian officer took over a load of lifebelts (found earlier in a German depot) and left them on the far shore. He made two trips with these, leaving about a hundred for those who cared to use them. Each trip he brought back a boatload of men. In the first trip he had about five casualties. In the second, hardly a man got out unhit; many were dead. It was a gallant effort but he could not be allowed to try again.

Some men used the life jackets there and then, some used them next night and some escaped by ways that are stories apart and remain to be told by the men themselves.

With mixed feelings we left the river bank in broad daylight. Fairly heavy shelling and mortar fire were directed on our lorries where they had unloaded. Two were burning. The rest were taken away with what boats that could be retrieved from the river.

The operation (it was called "Operation Berlin") had succeeded beyond the most optimistic expectations. There were many reasons for this. But two must never be forgotten—the sense of duty of the individual private soldier, and a Divine Providence watching over the whole affair.

"This was the Lord's doing and is marvellous in our eyes."

RECONSTRUCTION OF PATENGA AIRFIELD FEBRUARY—MAY, 1945

By Chief Engineer, Allied Land Forces, S.E.A.C.

Introductory

THE airfield at Patenga (near Chittagong in the Arakan) dates back to the early months of 1942, when construction was started on the peninsula which separates the Karnaphuli River from the Bay of Bengal. Originally a fighter and medium bomber airfield, it was reclassified in June, 1943, for heavy bombers and enlargements undertaken; these being finally completed in October, 1944. By this time, however, heavier loads had imposed an increasingly formidable maintenance requirement and it had been promised to close the main runway completely for a month and a half early in 1945. This hope was dashed by the arrival in January, 1945, of No. 4 Combat Cargo Task Force, flying supplies to Fourteenth Army in C 46s (Curtis Commandos) at the rate of 700 tons per day, off the long runway. 120 C.R.E. Works took over the construction of the necessary aprons, depots and roads, meanwhile attempting to keep the runways patched up and in usable condition.

We found the airfield in a fundamentally unsound state. The formation was of fine-grained, silty clay which contained no sand and softened rapidly when damp. This had been compacted by hand and had not been allowed sufficient time to settle before paving. On this were laid two runways; the main (N.E.—S.W.) was 6,000 ft. long by 150 ft. wide; the secondary

(N.W.—S.E.) 5,400 ft. by 150 ft.; these being linked by two dispersal taxi tracks with heavy bomber standings. The whole was constructed to a specification of 12 in. boulder soling; 3 in. waterbound macadam; seal coat of bitumen and ½ in. chippings, surfaced with bitumen and sand. Unfortunately the soling had been badly laid; the stones were not broken to size nor properly packed, so that large gaps were left through which the formation forced itself under pressure. Moreover, the surface drainage had been somewhat haphazardly conceived, and channels were discharging into natural watercourses of a tortuous character, with frequently insufficient fall (sometimes less than 1:1,000), thence direct into the Karnaphuli. A tidal bund system had originally surrounded the airfield but had been permitted to lapse. Finally, about 300 yards from its S.W. end, the long runway was crossed by an old drainage chaung containing some 17 ft. of semi-fluid silt clay which proved completely unstable.

As a result, maintenance in February failed conspicuously to keep pace with the deterioration of the runway. The surface started by crazing, developed into ruts, and once the surface seal was broken, the ingress of water accelerated the process to produce local collapse, particularly over the chaung. 120 C.R.E. Works reported to the D.C.E. that one shower of rain would render the runway unserviceable.

This was a very serious situation. The airfield would have to be in an all-weather state before the monsoon, which was only 3 months away. Meanwhile it was essential to the capture of Rangoon that the fly-in of stores to Fourteenth Army be continued from this airfield without interruption.

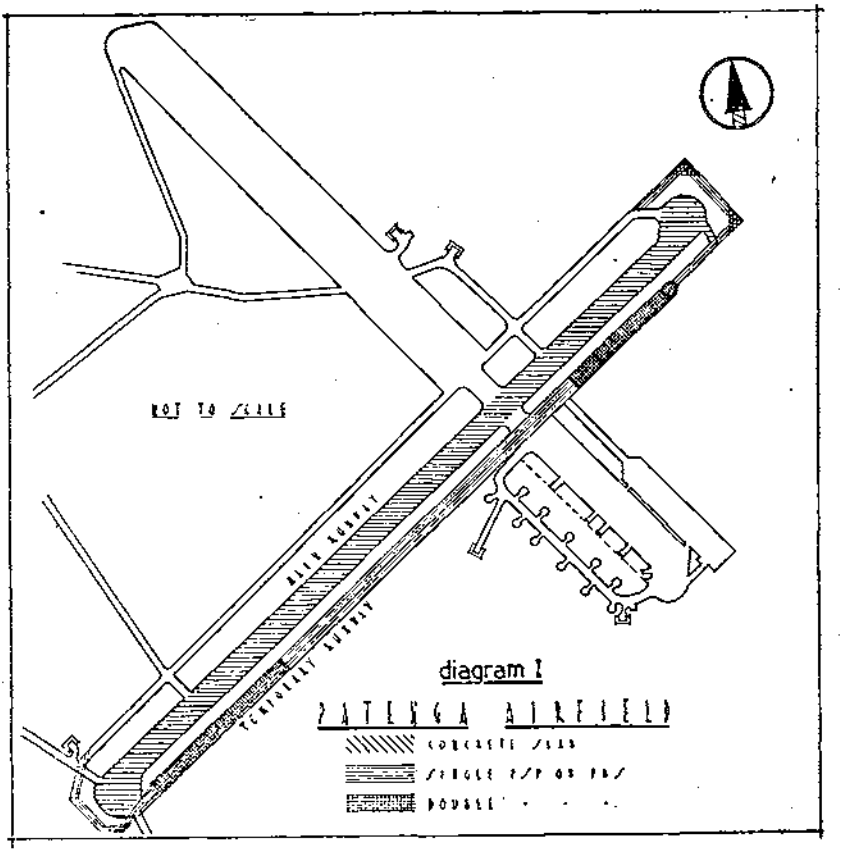
Planning

On the 15th and 20th of February conferences were held to determine a scheme of action. It was decided that a temporary runway 5,000 ft. by 100 ft. should be constructed parallel to the long runway, thus allowing the latter to be closed as originally promised. While closed, the runway was to be overlaid with concrete slab, from 5 in. to 7 in. thick and reinforced. All work to be carried out without interference with the supply and flying operations and to be complete by 15th May, 1945 (estimated for the onset of the monsoon). This work, under the title "Operation Honest," was given first priority. Units, material and equipment were allocated forthwith as shown in appendices and work started on 28th February, 1945.

Temporary Runway

The temporary runway (5,000 ft. by 100 ft.) was built on a fair weather strip running parallel with the main runway to the east, with 80 ft. clearance between the strips. The formation was graded and compacted by Mechanical Equipment with a cross fall of 1 in 20 from the main runway, and soft spots at the S.W. end were stabilized. Especially troublesome was the 140 ft. by 100 ft. patch on the line of the old chaung. This was first excavated to 3 ft. and back-filled with 2 ft. 3 in. of sand covered with 9 in. of selected earth. When attempts were made to consolidate this the blue clay squeezed up through the sand and it all had to be removed again. Excavation was then carried to 5 ft. and a Hertzberg mattress installed (see Diagram II), which proved entirely satisfactory. The surface was then smoothed by wobble wheel and smooth rollers and the whole area, complete with 3 ft. cut off, sealed with pre-fabricated bituminous surfacing (P.B.S.).

Laying P.B.S. by hand proved quicker than by "Stamplicker" (fluxing machine). The strips were unrolled and laid for the length of one strip right


NOT TO SCALE
MAIN RUNWAY
TECHNICAL RUNWAY
diagram I
PATENGA AIRFIELD
CONCRETE SLAB
SINGLE T/P OR PB/
DOUBLE

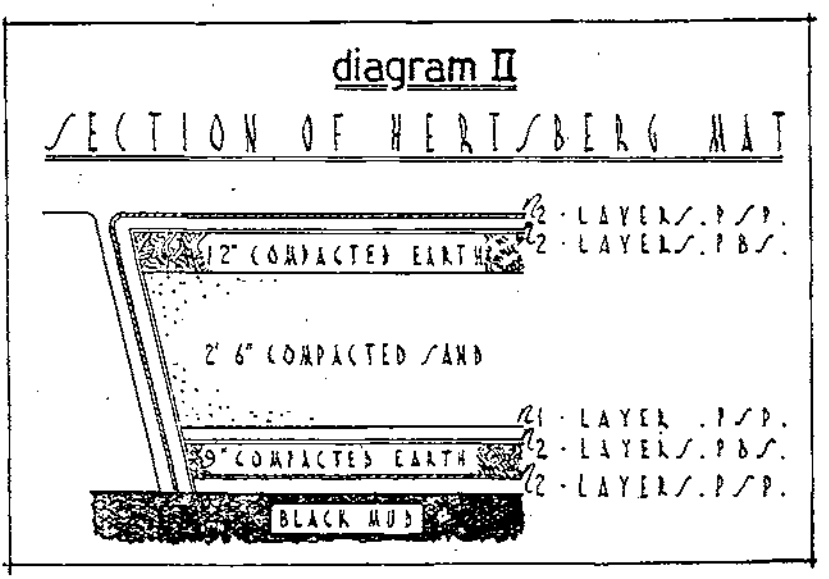


diagram II
SECTION OF HERTSBERG MAT
12" COMPACTED EARTH
2 · LAYERS . P/P.
2 · LAYERS . PB/.
2' 6" COMPACTED SAND
9" COMPACTED EARTH
1 · LAYER . P/P.
2 · LAYERS . PB/.
2 · LAYERS . P/P.
BLACK MUD

across the runway; 16 in. lapping being controlled by measuring sticks. The solvent (2 : 1 petrol/diesel oil) was sprinkled on from 4 gallon petrol cans perforated on the upper half of one side and was distributed by bass brooms. After four hours the surface was thoroughly rolled with a loaded wobble roller after which all kinks and wrinkles in the surface disappeared.

The P.B.S. was then overlaid with pierced steel plank (P.S.P.). Working outwards from the centre a single layer was placed, changing in the touch-down areas to two layers, the lower upside down. At the edges alternate planks projecting 5 ft. were bent down at 45° and buried in the cut off ditches.

This strip was connected to the original dispersal system by temporary taxi-tracks of single P.B.S. and P.S.P., leading round the ends of the long runway as shown in Diagram I.

The temporary runway took 36 days to complete, coming into use on 5th April, 8 days behind schedule. In spite of its limited size it proved popular with aircrews (except in strong crosswinds) on account of its fast surface.

Unfortunately the combination of traffic and rain caused complete failure of the temporary taxi-racks, and 75 ft. widths of turning circle on the main runway had to be given up as a replacement. But apart from the hold up to concreting in those areas no delay was caused. On the runway single P.S.P. tended to cut into the P.B.S. (in some cases penetrating both layers), but only slight rutting occurred under rain. The double P.S.P. gave a perfect all weather surface.

Running Repairs to Long Runway

Meanwhile, in order to keep the long runway serviceable until the temporary strip was ready, constant repairs were necessary. The runway was, therefore, closed officially from 01.00 to 04.00 hrs. daily and handed over to a repair gang (50 men strong). No excavation of soling was possible in the time; broken surfacing only could be removed. The exposed surface was hand rammed; clean stone was placed, grouted with hot bitumen and blinded with chippings. No plant was allowed on the runway except lamps from the lighting set. This partly succeeded in keeping the runway open, though latterly, 400 ft. at the N.E. end had to be denied to aircraft.

Reconstruction of Long Runway

The specification required a slab to be laid directly over the old runway; 5 in. thick at the sides, 7 in. thick at the crown. This was constructed of 1 : 2 : 4 concrete, reinforced with $\frac{3}{4}$ in. Sommerfeld rods, running longitudinally in the bottom, and 3 in. mesh B.R.C. fabric in the top. Haunching 9 in. wide by 18 in. deep was provided at the edges; over the chaung, ballie (round timber) piles, 10 ft. long by 4 in. diameter, were driven at 3 ft. centres and the slabs increased to 12 in. thickness. Where the old runway had lost its camber, adjustment was made in the finished levels to avoid wastage of material in abnormally deep slabs.

The runway was marked off into twenty 100 yard bays; parties being allocated to each bay, complete with tools and one 10/7 concrete mixer. Concrete was poured in daily tasks of 150 ft. by 15 ft. (twenty tasks per bay) running longitudinally with the runway. At the end of each task an expansion joint was made (2 layers of P.B.S.), and mock joints were cut every 20 ft. consisting of a $\frac{3}{4}$ in. deep, square groove, filled with bitumen. Longitudinal joints were merely painted with bitumen after the shuttering was struck.

The party on each bay was some 50 men strong, comprising sappers to

operate mixers, lay shuttering, steel and concrete, with pioneers to load the machine and carry the mix to the job. Each bay was provided with dumps of cement, aggregate and sand, water being laid on by a flexible 2 in. connexion to the mixer. Except when rain stopped work, all parties achieved their task daily.

Concreting materials were required in continuous supply from the beginning of April. Cement came up by rail according to programme, and without hitch. Sand was carried by lorry from the beach, 3 miles away. Loading was effected by an Osgood power shovel, fed by a D4 from a sand heap (100 ft. square by 5 ft. deep), previously amassed by an 8 yard scraper. The shovel was able to remain stationary, and lorries were loaded in under 2 minutes.

The provision of the required 19,000 tons of aggregate (2 in. and down) caused rather more difficulty. A total delivery of 12,000 tons of 2 in. stone was expected from Vizag, Feni and Bhairab Bazar in India; the balance to be made up from the existing stock of boulder and quarried stone (6,000 tons each), for which purpose 8 crushers were installed. Unfortunately mechanical trouble with the crushers and Decauville locos cut down the output from this source; moreover the 2 in. stone from Vizag arrived as 4 in. down and the Feni stone was river ballast. As a result crusher output was relied upon daily, supplemented by screening from the Vizag stone. Overhead screens were erected on the jetties, screened stone dropping straight into lorries, rejects being taken to the crusher yard. Here the Decauville system was abandoned; stone piled up at the crusher foundations and was loaded by D4 and power shovel into the lorries. By this means sufficient stone was prepared to implement the pouring programme.

The organization of transport set a major problem. Besides the importation of some 1,100 tons per day of engineer materials for reconstruction purposes, the fly-off required 1,000 tons per day of military stores to be fed into dumps and subsequently distributed to aircraft, while a number of R.A.F. vehicles were at work servicing the planes. Congestion was intense.

Engineer transport was handled on a task system; a set number of journeys for each driver; and a set amount of material to be cleared for each loading gang. Each vehicle had the delivery bay number chalked on its side before leaving the dump, and check points ensured control of the transport programme, loads being recorded daily.

Pouring started 3 days after the runway was closed, on the 8th April, and finished on the 5th May (apart from portions of the turning circles which were in flight lanes of the temporary runway). The reconstructed runway became operational on the 14th May—one day ahead of schedule.

Conclusion

This concludes the story of "Operation Honest," but the account would not be complete if no mention were made of some attendant circumstances which went to make it more difficult. In the first place, a great deal of work was going on simultaneously on other parts of the airfield. Aprons, roads, and depots were all under construction, while the short runway was being completely rebuilt to a specification of 8 in. soling, 3 in. tarmac with chip coat on a 3 in. bed of sand. Secondly, the continual failure of taxi tracks and consequent interruption of work (while diversions were arranged) proved a disturbing factor. Far more so was the fact that all work was carried out within 30 yards of a strip, which was, in May, creating a record of nearly 1,000 tons per day sent off to forward airfields—a condition especially disconcerting in

a strong cross wind. The completion of the work to schedule in spite of these factors, quite apart from the various snags in the supply of materials and in building, qualifies the Patenga reconstruction scheme to rank as a fine feat of engineering.

APPENDIX I

Temporary Runway Details

A.—*Allocation*

Labour:	1 Field Coy. I.E.	Plant:	15 Scrapers (with tractors).
	1 Mech. Equipt. Pl. I.E.		4 Graders.
	2 Indian Pioneer Coys.		5 Tractors.
			Rollers, stamplickers, etc.
Material:	595 tons P.B.S. (706,602 sq. ft.)		
	2,194 tons P.S.P. (921,565 sq. ft.)		

B.—*Output Figures*

P.B.S. Rolls laid per sapper per day ..	4 Rolls Average.
	8 Rolls Max.
P.S.P. Planks laid per sapper per day ..	35 Planks Average.
	60 Planks Max.

All sappers initially untrained in laying. Towards the end maximum or near maximum output was achieved daily.
Mech. Equipt. Total working time .. 1,350 hrs.

APPENDIX II

Concreting Main Runway

A.—*Allocation*

Labour:	2 Field Coys. I.E.	Plant:	5 Excavators.
	1 Engineer Bn. I.E.		8 Crushers.
	4 Indian Pioneer Coys.		7 Diesel Locos.
	600 Civil Pioneers.		1 Mile Decauville Track.
Material:	19,000 tons 2 in. aggregate.		32 Decauville Tipping Wagons.
	11,500 tons sand.		2 Mobile Cranes.
	5,275 tons cement		40 Concrete Mixers.
	900 tons reinforcing steel.		
	6,500 tons chips.		

B.—*Output Figures*

Average:		Peak:	
Output of concrete daily on 15 ft. wide lane ..	17,000 cu. ft.	One 15 ft. lane of concrete full length of runway ..	45,000 cu. ft.
Per Sapper ..	23 cu. ft.	Per Sapper ..	60 cu. ft.
Per Pioneer ..	15 cu. ft.	Per Pioneer ..	40 cu. ft.
Average per man ..	19 cu. ft.	Average per man	50 cu. ft.
Per Mixer (approx.)	52 tons	Per Mixer ..	181 tons

Peak output occurred on 7 separate days.

Temporary Runway.

Showing proximity of aircraft to work.

Main Runway in use.

Reconstruction of Patenga Airfield Feb-May 1945

Norske Hydro Plant at Rjukan.

Op Freshman

OPERATION " FRESHMAN "

(An account of the raid by 1st Airborne Div. Engineers on the " Heavy water " plant in Norway.)

By Q.M.S. D. F. Cooper, R.E.

ONE of the most important tasks given to airborne and other special service troops during the war was the dislocation of German experiments for the production of an atomic bomb. Attacks on German research installations were started in 1942. The objective was the destruction of existing stocks of " heavy water " (a compound extremely difficult to produce in any large quantity), and the electrolysis plants where it was being made. The main enemy heavy water installation was the Norske Hydro plant at Vermork, a village three kilometres to the west of Rjukan.

Rjukan, the main place where electricity is generated in Southern Norway, is about eighty kilometres due west of Oslo. Its only connexion with the outside world is a second-class road, which is frequently blocked by the winter snows, and a ferry. The railway there connects the Tinnsjon ferry with the electrical plants. The town is situated in a very deep valley, the thickly forested sides of which rise almost vertically from a narrow river bed to over 3,000 feet. So deep is the valley that throughout the winter the sun's rays never reach Rjukan's streets. From a height of 5,400 feet, Gaustal Fjell overlooks the valley, and it is from the great slopes of this mountain that the water power, which drives the numerous turbines of Rjukan and Vermork, is derived. The " heavy water " plant is built on a broad shelf of rock which rises sheer from the riverbed to a height of 1,000 feet: the climb above is dangerously steep through a thick pine forest.

Combined operations headquarters handled this particular attack on these installations, which were made by both Norwegian and British troops. Other attacks were successful. Operation " Freshman " was a gallant attempt which failed.

The intention was to destroy, once and for all, the accumulated stocks of heavy water at Vermork, the major pieces of machinery of the electrolysis plant used for its production, and the power station situated at the rear of the plant. This entailed the use of a considerable quantity of explosive, and a high degree of technical training. Three methods of attack were considered—by bomber aircraft, by saboteurs, and by airborne troops. The first, although used with partial success late in 1943, was ruled out because of the difficulty in finding the target, (night bombing was then the R.A.F.'s chief method of attack), and also because bombing would without doubt involve a high loss of life among the Norwegian population. Attack by Norwegian saboteurs was also ruled out, although by this method success was eventually attained. An attack by airborne troops was considered best. Landing by flying-boat on Tinnsjon was considered, but the steepness of the surrounding mountain slopes rendered this impracticable. Parachuting was considered possible, but was given second priority to landing a force by glider.

Technical considerations necessitated a minimum force of 12 to 15 men. With a view to the hazards involved and the importance of the task, it was decided to duplicate the force, so that it finally consisted of two gliders each carrying 1 officer, 1 serjeant, and 13 other ranks of the Royal Engineers, and two glider pilots. The gliders to be used were Horsas Mk. 1., and the tug aircraft were to be Halifaxes.

The First British Airborne Division was given the task in the middle of October, 1942, and the period decided on for the operation was during the November moon. Moonlight was essential, and the horoscope showed that only during the period 18 to 26 November would the moon cast sufficient light into the valley to assist the attacking force.

The choice of a landing ground near the target presented difficulties because of the mountainous country in which the Rjukan valley is situated. The alternative was to land the gliders a considerable distance from the target and make an approach march of several days. The concealment of the gliders and the carriage of rations additional to the already heavy weight of explosive over long and difficult roads, which would probably be covered with a few feet of snow, put this out of the question.

Eventually it was decided to land on the marshy edge of Mosvatnet (Lat. 40 degrees 50 mins. N., Long. 8 degrees 10 mins. E.). An advance party of Norwegian agents was to mark the landing zone with lights. From these same agents was to come the latest news of enemy dispositions in the area, and local meteorological conditions.

It was decided to mount the operation from Skitten airfield—a satellite of Wick in Scotland—and make a landfall at Egersund. From there the craft were to fly direct across the mountains to the landing zone. On arrival, the first party was to wait up to half-an-hour for the second, and then, if it did not appear, to proceed independently. The advance party of Norwegians was asked to produce guides to the target. On their arrival the sappers were to enter the electrolysis plant and power station, working by sub-sections, and destroy in order of priority the existing stocks of heavy water, the machinery for its production, and then damage the power station as much as possible. On completion of these tasks the force was to split up into small groups of not more than three men and to make its way to Sweden.

The officer in charge of training the party and producing the detailed plan was Lieut.-Colonel M. C. A. Henniker, D.S.O., O.B.E., M.C., R.E., at that time C.R.E. of the 1st Airborne Division. He was assisted by Major I. D. Irvine, R.E., and Captain J. N. Chivers, R.E., then O.C. and Second-in-Command respectively of 261 Field Park Company R.E. (Airborne). Commanding the air side of the operation was Group Captain Cooper, D.F.C., R.A.F. from 38 Group, R.A.F. The officer in charge of the raiding party was Lieut. A. C. Allen, R.E., and commanding the second glider was 2nd Lieut. M. D. Green, R.E. The latter was injured in an accident, and his place was taken by Lieut. D. A. Methven, G.M., R.E. only three days before the operation was due. The selection of the men produced a few difficulties, as it was not until after training had begun that it was finally decided to transport the force by glider and not by parachute. The men selected, therefore, had to be fully trained parachutists. The only R.E. parachute unit at that time was the 1st Parachute Squadron, R.E. which was already fully committed with the British 1st Army and was waiting in Scotland ready to fly to North Africa. Fortunately there were about fifty volunteer parachutists in 9th Field Company R.E. (Airborne), and 261 Field Park Company R.E. (Airborne), the two other units of the Divisional Engineers. From these units sufficient volunteers were forthcoming, although none knew what the operation involved. It stands to the credit of each individual sapper that he readily volunteered for

an operation of which he had not the slightest knowledge, its difficulties, dangers, or of his chance of survival.

The basic principle of all training was individual physical fitness. The technical training presented few difficulties apart from specialized training in recognition of machinery parts, and their destruction. The first week's training was devoted to welding the men into a unit, and consisted of drill, weapon training, map reading, and route marches. Particular attention was paid to observation. The men were posted to watch and report on sentries and guards of units in the district without themselves being seen. The second week was spent hardening them in the mountains of North Wales. They marched over the mountains carrying 10 days' rations, with small scale maps, sleeping out in all weathers, and living only on hard rations. The third week was devoted to technical training arranged by Combined Operations H.Q. It included visits to plants, similar to the target, in England and Scotland. The fourth and last week of training was spent on Salisbury Plain, fitting out with special equipment, and in rehearsing the attack.

On Monday of the fifth week, three days before take-off, the troops moved to their base airfield.

The air side of the training was more complicated. The aircrews of 38 Group, who had recently been flying only Whitleys and Wellingtons, had to fly the Halifax, and with it practise towing a Horsa glider. This gave the glider pilots, skilled as they were, little time to practise their ground role and attain the very high standard of physical fitness required of them.

In the air side of the operation lay its greatest hazards. A long night tow of 400 miles (with always the possibility of a return flight if the tug aircraft could not find the target) was far in advance of anything previously attempted. In addition there were the natural hazards of sudden changes of weather as soon as the aircraft reached the mountains of Norway, and probably, the greatest of all, the night landing in the fragile craft on a small, presumed marshy, area on which ice and boulders might well be encountered.

Security was a most important aspect of this operation. Bad security would not only prejudice the lives of these thirty-four men, but also prevent a further attack should this one fail. A cast-iron cover story was put out telling of the challenge of a company of American engineers for a mythical " Washington Cup." This reputed competition involved a long approach march by either glider or parachute, followed by a complicated demolition task, and concluded with a strenuous endurance test. Under this cover the whole of the training, movements, and demands for stores were made without arousing suspicion. The challenge was talked about openly and there is no doubt that all who had contact with the force, the cooks, the cobblers, quartermasters, and the unit workshop personnel, who made some of the equipment, were fully convinced by the story.

On the security side all went well until a training establishment insisted that the party should arrive without berets and Divisional signs. This at once aroused suspicion in the two units, when the men marched to the station without Divisional signs and in F.S. caps. It is common knowledge among Airborne troops that when an airborne soldier puts on an F.S. cap " something is up."

Skitten airfield was sealed when the party arrived, and all mail and telephone calls were censored. Unfortunately an operational squadron was taking off at the same time as the gliders were coming in to land, and some of the crews must have seen them. Despite this, however, security remained good, and the field security police detachment, which accompanied the party throughout its travels, never once heard a whisper of the real intention of the raid.

The operation was scheduled to take place on the night 19–20th November, or the first suitable night following. The final decision lay with Group-Captain Cooper, who was himself to fly with the tug aircraft. He had to assist him, a meteorological expert on Norway, and to advise him he had the latest report from the agents on the spot. The forecast for the night 19–20th was reasonable enough, though not ideal, and with the possibility of a deterioration in the weather for the remainder of the November moon period it was decided to mount the operation that night.

By the same morning the final details had been checked thoroughly, and both aircraft and gliders were ready to take off. The morale of the force was unbelievably high and many jokes about the days to come were made among the men to relieve the tense atmosphere which had developed.

The orders to the parties were precise and clear. On landing they were to rendezvous with the guides. Lieut. Methven, two sappers and a Norwegian guide were to act as advance party. The remainder were to move in a formed body under the orders of Lieut. Allen.

The main object during the five-hour approach march was to avoid detection. Any enemy sentry encountered was to be killed ; a party would be left to cut the telephone wires around his post, and would then rejoin the main force. A man who was wounded was to be given morphia and left by the roadside. A man who fell out, for whatever reason, was to be left behind and the main body must press on. " Whatever happens, someone must arrive at the objective to do the job—detection is no excuse for halting." This last order was modified during the last two days before take-off to say that if, through any misfortune, a glider landed in some totally unexpected place, the officer or senior passenger would decide whether it was practical to attack the objective or to try and escape to Sweden.

The first aircraft, captained by Sqn.-Ldr. Wilkinson, R.A.F., in which Group-Captain Cooper flew, took off at 17.50 hrs. The glider was flown by Staff-Sjt. M. F. C. Strathdee, A.A.C. and Sjt. P. Doig, A.A.C. and the troops were under command of Lieut. D. A. Methven, G.M., R.E. His N.C.O. was Lance-Sjt. Healey, and with him were Cpl. Cairncross, L.-Cpls. Jackson and Masters, Sappers, Blackburn, Bonner, Welsh, White, Hunter, Jacques, Norman and Smith and Drivers Farrell and Simkins.

The second aircraft, captained by Flight-Lieut. Parkinson, R.C.A.F. took off at 18.10 hrs. The glider in tow was flown by Pilot Officer Davies, R.A.A.F. and Sjt. Fraser, R.A.A.F. The troops were commanded by Lieut. Allen, R.E., whose senior N.C.O. was Lance-Sjt. Knowles. The remainder of this force comprised Cpl. Thomas, L.-Cpls. Bray and Campbell, Sappers Williams, Bailey, Grundy, Legate, Faulkner, Bevan and Smallman, Drivers Belfield, Pendlebury and Stevens. It was still light when this second take-off had been completed, and the aircraft and tug circled the airfield and headed out across the North Sea.

The first news to reach the base airfield was a faint signal at 23.41 hrs. that night, which was believed to have come from the second aircraft, asking for a course to bring it back to base. This signal was also picked up by another R.A.F. station, and by intersection of bearings it was found that at the time of despatch the aircraft were still over the North Sea.

At 23.55 hrs. a second signal was picked up, this time from the wireless operator of the first aircraft,—" Glider released in sea." By intersection of bearings the position of the craft was found to be over the mountains of Southern Norway, and at 01.51 hrs. on 20th November, when the aircraft returned to base, this position was confirmed by a careful check of times and course. The glider had been released just over the coast but nowhere near the target.

On the outward flight radio communication failed as the aircraft neared the Norwegian coast. A landfall was made and the tug flew towards the target, but without success. On a second attempt the aircraft ran into thick cloud in an area about 40 miles northwest of Rjukan and was unable to climb out of it. By this time there was barely sufficient petrol to get the tug and glider home. Ice was forming on the craft, and worse still, on the towing rope. Both tug and glider lost height rapidly, and eventually in the area of the Norwegian coast the rope completely iced up and broke. It was at this point that the wireless operator had sent out his signal.

No further signal came from the second aircraft, and the tug-plane itself failed to return. From first light on 20 November two squadrons of coastal command aircraft and a destroyer searched the area from which the last message had been received, but nothing was found.

On 21st November, this announcement was made over the German wireless, and repeated, without comment, in the English newspapers on the morning of 22nd—

> " On the night of November 19–20th two British bombers each towing one glider flew into Southern Norway. One bomber and both gliders were forced to land. The sabotage troops they were carrying were put to battle and wiped out to the last man."

Agents reported that no troops reached the target area, and Operation " Freshman " was over, and for us the matter closed. In the interests of the safety of any man, who might have escaped and still been at large in the country, notification to the next of kin was delayed as long as possible. For the security of future attacks on the plant, all papers held by H.Q.R.E. 1st Airborne Division were burned.

No further information was received for over two and a half years, until after troops of the 1st Airborne Divisional Engineers flew to Norway on 10th May, 1945. Within a week of their landing a slight clue was found in the town of Kongsberg, half way between Rjukan and Oslo. Here, an officer and N.C.O. of the Divisional Engineers met one of the advance party who had waited patiently that night at the landing zone near Mosvatnet for the two gliders which never came. About ten or eleven o'clock that night he had heard the engines of a heavy aircraft which presumably was that in which Group-Captain Cooper, had been flying. It came almost overhead and then circled away to the west. At any moment he had expected to hear that swishing sound that heralds a landing glider ; but none came. " Freshman" had been within an inch of attaining success ; it seems that only a belt of cloud had frustrated it. He was unable to tell us anything of the fate of the men, only that he always understood that a glider had crashed " somewhere down in the south-west."

The second and most important clue, which in the long run proved to be fairly accurate, came from a sapper travelling by train from Stavanger to Kristiansand. At the station in the small village of Sira he became engaged in a conversation with the railway porter who told him that a glider had landed at Helleland with 17 occupants on board. Two of these had been killed in the crash, and one injured. The remaining fourteen were taken to Egersund, terrorized, and finally shot. The porter did not, however, have any idea of the place of burial, the names of anyone concerned, or what had happened to the injured man. This information was forwarded to the Zone Commander at Stavanger, and very soon the story began to take shape. Interrogation of Norwegian civilians and police, and of German prisoners by a War Crimes Investigation team has now completed the story.

When the glider was released from the surviving aircraft at five minutes before midnight, it was just north of Stavanger. It crash-landed at Fylesdalen on top of the snow-covered mountains overlooking Lsefjord. The weather was extremely bad and it was snowing at the time. In the crash, Lieut. Methven, Lance-Sjt. Healey, the two pilots, Staff-Sjt. Strathdee and Sjt. Doig, Sappers Hunter, Jacques and Norman, and Driver Simkins were killed immediately. Norwegian civilians helped German soldiers to bury them in a communal grave, marked by a simple wooden cross. After the Germans had left, the Norwegians fenced off the grave to prevent the cattle from wandering over the ground. They planted flowers at the head, and when a party of sappers went to the spot in the summer of 1945 they found the grave was in good condition and had been well tended by the Lensmann.

Four other men, Cpl. Cairncross, L/Cpl. Masters, Sapper Smith and Driver Farrell, were all severely injured in the crash. They were taken to Stavanger hospital and then to Gestapo headquarters, presumably for questioning. Eventually they were poisoned by a German Medical Officer. Their bodies were heavily weighted with stones, taken out into the fjord, and dumped overboard one hour's sailing time from Stavanger. No idea of the position of their burial is known.

Five men were uninjured in the crash; they were L/Cpl. Jackson, Sappers Bonner, Blackburn, Welsh and White. Their clothes were soaking wet, and they obtained a change of clothes from a nearby farmhouse. While they were tending to the four wounded men, German troops arrived and they were taken prisoner. They were removed to Stavanger County jail, and later sent to Grini concentration camp, north of Oslo, where they arrived on the first of December, 1942, and were placed in separate cells. Blackburn had a dislocated shoulder and suffered considerably as he was unable to sleep on the hard bed in the prison. Eventually it was put right by the German Medical Officer of the prison—Dr. Ritz. On the 24th December, they were all put in one cell and were questioned many times by a Luftwaffe officer. During the questioning he told them that it had been proved that they were British soldiers and soon would be sent to a P. of W. camp.

All the time the men were in Grini they were in close contact with a Norwegian soldier, Cpl. Eric Dahle, and it is from him that these details are known.

At one a.m. on the 18th January, 1943, they were all taken away in handcuffs. This is the last Dahle saw of them. At dawn that morning the men were taken for an interview with a "Special German Delegation," and for this they were blindfolded. When the delegation arrived the men were called to attention. The word used was "Achtung"—it was the fire order for the execution squad. They were buried at Trandum with a British seaman and some Norwegian civilians who had suffered a similar fate.

Flight-Lieut. Parkinson's aircraft and its glider crashed immediately after crossing the Norwegian coast. A land fall was made near Egersund and the tug and glider headed towards Rjukan. It is not known exactly what happened next, or the cause, but the glider crash-landed into the mountains north-east of Helleland, and the tug plane managed to hop over the mountains at that point, crossed the village of Helleland and then crashed into other mountains directly to the south near the farm of Helleren. In the tug plane all the crew were killed in the crash and were buried on the spot by German soldiers and Norwegian civilians.

Only three men were killed in the glider crash and it has not been established which three these were. Two men from the glider went to the nearby farmhouse for help at two o'clock in the morning, and at their request the Lensmann 'phoned the local doctor. Norwegian civilians hurried to the spot to render what assistance they could and to warn the troops of the approach

of German soldiers. The officer or N.C.O. in charge must have decided, however, that it was impracticable to reach either the target or Sweden and decided to surrender. Very soon German troops arrived and the force, including the dead, were taken in two lorries to the German camp at Egersund. Within a matter of hours all the survivors were executed by a firing squad, in accordance with the " Order of the Fuhrer," which the German zone commander held to be valid in this case. The order read (as far as can be confirmed) :—

> " Caused by the growing number of cases, where planes are used for the landing of saboteurs, and as through this great damage has been done, I hereby order that crews of sabotage planes are to be shot at once by the troops isolating them."

After the execution all clothes were removed from the bodies, and together with the bodies of the men killed in the crash, they were taken a few miles further north to the sand-dunes of Brüsand, two kilometres north of Ogna. A farmer told a British officer that a lorry containing 17 bodies of British soldiers who had been shot was driven up to the place ; a trench was dug in the sand and the bodies thrown in. No decent burial was in any way attempted. The grave was neither marked nor tended.

The Germans returned to the scene of the crash and after many inspections by Luftwaffe officers, the glider was burned. Before they had time to do this the Lensmann had searched the wreckage and found a notebook in which was written the name " George Knowles." He hid the book from the Germans, but later himself lost it. He described the dress of the soldiers who came for help as " Ordinary British battledress, with a field service cap. One was wearing a blue sweater on the top of his blouse." To the Norwegians who came in contact with the party there was no doubt that they were British soldiers. When asked by the Norwegians what would become of the troops, a German officer stated that they would, of course, be treated as prisoners of war.

The seventeen bodies at Ogna were exhumed in July, 1945, and were re-buried by men of their own units on the 19th of July, 1945, with full military honours, in the quiet cemetery of Egenes on the outskirts of Stavanger. Many men who had served with them in earlier days made up the guard of honour. During the lying-in-state the coffins had been draped with the Union Jack and covered with roses. A large crowd of Norwegian civilians attended the funeral, and in the town of Stavanger all flags flew at half mast.

On the 18th of August operations were commenced to recover the bodies of Lieut. Methven and his men from the top of the steep cliffs of the Lysefjord. the only access was by boat to the head of the fjord and then a four-hour climb up the cliffs. Many difficulties were encountered by the R.E. party, but these were overcome and on Wednesday, the 22nd of August, all eight were re-buried with the seventeen from Ogna.

It was not until the end of August that the bodies of the five men shot at Trandum were recovered. They in their turn were buried with full military honours, this time in the military section of Vestre Gravlund Cemetery, Oslo.

Thirty of the thirty-four had now been re-buried, twenty-five in Egenes and five in Oslo. Unfortunately we were unable to recover the four from the fjord.

To the memory of the force there stands near the grave in Egenes a black

granite stone. At the head of the stone is engraved the Divisional emblem, under which these men had served, the winged Pegasus. Below this the words:—

In Memory of
Thirty Royal Engineers
of the
1st British Airborne Division
Two Glider Pilots
of the
Army Air Corps
and
Two Pilots
of the
Royal Australian Air Force
The occupants of two gliders which crashed at Helleland and Fylesdalen on 20th November, 1942, whilst engaged on a gallant mission against the German atomic bomb research installation at Rjukan.

Og det er det stora
Og det er det glupa
At Merket det stend
Um Mannen han stupa.

Per Sivle.

The erection of this stone terminated the activities of 1st Airborne Division R.E. Meanwhile the war atrocity aspect has been vigorously pursued by officers of the War Crimes Investigation team. By the time this Division left Norway in the first days of September, most of the Germans involved in these executions were imprisoned in Norwegian civil gaols.

Fehlis, head of the Gestapo in Oslo, who was reputed to have signed the execution order for the men at Trandum, committed suicide a few days before the landing of the Divisional advance parties in May, 1945. Hpt. Stufu. Hans, Commander of the execution squad, is in Akershus fortress at Oslo with Hpt. Stufu. Esser, one of their interrogators at Grini, awaiting trial. Colonel Probst, second-in-command of Stavanger zone, who was actively concerned in the execution of Lieut. Allen and his men, was placed under close arrest on the 11th July by the British Zone Commander at Stavanger, Brigadier R. G. Loder-Symonds. Colonel Probst was later moved to the Akershus; he is dying from a cancer in the throat. The German medical officer responsible for the poisoning of the four men at Stavanger and his colleague at Grini, Dr. Ritz, have also been imprisoned.

The day is not far off when all these men will be brought to trial before military courts.

THE WAR BOOKS CONTINUE

By J. E. E.

THE Victory celebrations already seem a long time ago; but the supply of new War books has not diminished to any great extent; and one may be sure that there are many still to come. When more labour and material are available to the printing and binding trades larger editions, and many reprints, can be expected.

Popular serial publications have not overtaken the march of events. Thus, that comprehensive work edited by Philip Graves deals with the crowded period April to June, 1944 in *The Nineteenth Quarter* and, in *The Twentieth Quarter*, July to September, 1944, carries on the story of Allied successes in Europe whilst bringing forward the account of the Pacific offensive. Edward McInnis, with his *Fourth Year*, which starts with the turn of the tide in September, 1942, has not progressed so far; he offers the attraction of a rather dramatic preface by Viscount Wavell. *Foothold in Europe*—the title refers to the invasion of Italy—is the seventh volume of "Strategicus" who covers therein the campaigns of Sicily, Italy, the Far East and Russia between July, 1943 and May, 1944. All these books maintain their high standard, and not only the general reader but also the student and the historian may find them useful for reference. *The Daily Telegraph Story of the War*, for the year 1944, in calendar form as before, and *Hutchinson's Pictorial History of the War*, September, 1944–March, 1945, with its admirable illustrations numbering nearly a thousand, are other publications to buy and keep. The seventh and last volume of J. L. Hudson's "war diary," *The Sea and the Land*, resembles it predecessors in that it contains much good reading although discursive and disconnected.

Expert descriptions of the Normandy landings and of the course of the Pacific War will be found in *Brassey's Naval Annual*, 1945; the editor himself, Rear-Admiral Thursfield discusses the objections to the fusion of the three fighting services. A. D. Divine, who has had the use of the logs of the "little ships" and other official records tells, in *Dunkirk*, a fine story of the evacuation of the beaches. Another outstanding production is *The Battle of the Narrow Seas* in which Lieut.-Commander Peter Scott, R.N.V.R. relates the achievements of our "light coastal forces" which showed themselves the masters of the E. boats and R. boats during many an encounter in the Channel and its North Sea exit. The author's own paintings and sketches and some excellent photographs provide the illustrations. The M.O.I. booklet *H.M. Submarines*, prepared for the Admiralty, is a well-written record, but all too short. Of a rather different character is Lieut. R. N. Jewell's *Secret Submarine Mission*, the author having commanded H.M. "Seraph" which took General Mark Clark of the U.S. Army to North Africa before the Allied landing; this and other submarine adventures were told in a Canadian lecture tour and are published from New York. Accounts of a particular ship and its ship's company possess a particular attraction; in this category come Keith Douglas Young's *The Silver Phantom* (H.M. cruiser "Aurora") compiled by several hands; *Flat-Top* (an escort carrier) by F. D. Ommanney; and *The Price of Admiralty*, a tribute to the ships and men of the Royal Australian Navy, by Paul and Margaret Maguire, as exemplified by the career of H.M.A.S. "Parramatta" eventually lost at Tobruk. Richard Fisher, who was liaison officer with the French minesweeping service, relates in *With the French Minesweepers* how efforts were made to keep clear of hostile mines the French ports before the Germans occupied them in 1940. In *Seven Sailors*, Commander Kenneth Edwards provides a collection of naval biographies, including one of Sir

Bertram Ramsey. Very welcome and unique in its way is *Looming Lights* by George C. Carter a member of the lightship service, who tells how his fellows withstood the deliberate attacks of the Luftwaffe during the Battle of Britain. This is a phase of the War too easily forgotten.

As regards the naval achievements of our Allies, *America's Navy in World War II.* by Gilbert Cant is comprehensive and well compiled; Lieut.-Commander A. Kroese's *The Dutch Navy at War,* in Europe and the Far East from May, 1940, is well documented.

The R.A.F. does not claim much notice on this occasion; but *Coastal Command Leads the Invasion* by Michael Wilson and A. L. Robinson describes the special offensive against the U-boats which was an important item in preparation for the Normandy landings. *The R.C.A.F. : The First Four Years* is an admirable record which, of course, does not include the services of those Canadians who remained in the R.A.F. Alan W. Mitchell's *New Zealanders in the Air War,* with forewords by Sir Archibald Sinclair and Mr. W. J. Jordan, High Commissioner in London, puts on record the services of those of the Dominion who did serve in the R.A.F. : a series of stirring stories.

By Air to Battle, the official pamphlet describing the exploits of our two airborne divisions, the 1st and the 6th, contains much not hitherto revealed and whets the appetite for more. Another of the official series, *The Royal Armoured Corps,* carries us up to the end of the North African campaign, but is more remarkable for its illustrations than for the length or strength of its narrative.

Turning to the last phases of the War in Europe it should be noted that Field-Marshal Montgomery's most interesting lecture on the campaign of the 21st Army Group, given at the Royal United Service Institution in October last year, has been published with excellent maps, in pamphlet form. In *First Tide,* Alan Melville writes of D-Day and the fighting in Normandy; Alan Moorehead supplies in *Eclipse* a well informed account of the final stages of the European struggle, describing also the British occupation of Germany; and Leonard O. Mosley, who was with the Second Army, covers some of the same ground with his *Report from Germany.* An exciting tale is told by Claude Roy in *Eight Days that Freed Paris ;* for he was one of those who took part in the rising of the F.F.I. which did much to hustle the Germans from the city. Finally we come to Count Folke Bernadotte who has placed on record his activities as intermediary, through the Swedish Red Cross, in a German offer of capitulation : this story, originally partly told in the *Daily Telegraph* has been published in translation under the title *The Fall of the Curtain.*

Two stories of personal adventure are worthy of attention. Jean Brilhac in *The Road to Liberty* tells how a band of Frenchmen broke from a German prison camp and escaped by way of Russia; *Farewell Campo* 12 by Brigadier James Hargest (killed in action two months after the Normandy landings) relates how the author escaped from his Italian prison after being captured in Libya.

Those who are in danger of forgetting German crimes should read *Axis Rule in Occupied Europe* by Raphaël Lemkin, a Polish lawyer who provides a dispassionate survey of Nazi tyranny; *The Exploitation of Foreign Labour by Germany,* prepared by Mr. John Fried, an official of the International Labour Office; *The Promise Hitler Kept* wherein Stefan Szende presents eye-witness accounts of the wholesale slaughter of Jews in Poland; *War Criminals and Punishment* by George Criel, a Washington correspondent who knows the worst of the Germans and the Japanese; and *Dungeon Democracy* by Christopher Burney, a British officer who spent fifteen months in Buchenwald, where the S.S. guards gave internal control of the camp to German Communist

prisoners who shamefully maltreated the other inmates. Victor Gollancz, referred to in the previous article, has been answered—and well answered—by Franz Burger (who was confined both at Buchenwald and at Dachau) in *Gollancz's Buchenwald Never Existed.* A clear warning as to the present and future is contained in *Assize of Arms* by Brig.-General J. H. Morgan, K.C., who was a legal member of the Disarmament Commission; he shows very clearly the subterfuges, tricks and lies by which the Germans eluded the provisions of the Treaty of Versailles, and also disposes of many popular fallacies and misconceptions regarding the treatment of Germany after the 1914–18 War.

Turning to Russia, *From Moscow to the Russian Frontier* is a selection from the despatches of Evgeny Krieger, a Red Army correspondent who witnessed plenty of fighting; *With the Red Army in Poland and Byelo Russia,* in translation, contains the account by Vassili Grossman, of the operations in June and July, 1944, which carried the Russian advance beyond the Niemen. This is the work of a practised war correspondent who shows how the Germans were out-generalled and out-fought. *From Belgorod to the Carpathians,* by Boris Polevoi, the "Pravda" representative, covers the operations of Koniev's forces during the 1943–4 winter; but it is not well translated and has little technical information. *Partisans of the Kuban* by P. K. Ignaton, translated, is an interesting account of guerrilla warfare, and Major-General Formichenko's *The Red Army* is a popular description of the Russian fighting machine with a sketch of Stalin's career. Mrs. Churchill, who initiated British Red Cross aid for our Ally, has written a graceful and sympathetic little book called *My Visit to Russia.*

Before leaving Europe there may be mentioned the two volumes of "Pertinax" called *Les Fossoyeurs,* the grave-diggers being Gamelin, Deladier, Reynaud and Pétain; the weaknesses and limitations of each are ruthlessly portrayed and there is much here which helps to explain the downfall of France. Camille M. Cianfarra, former Rome correspondent of the *New York Times* in *The War and the Vatican* defends with vigour and ability the papal policy during the war years.

The African campaigns appear to be a favourite theme no longer; but in *Come to Dust* tank warfare in the Western Desert, 1941–2 is well described by Robin Maugham, a junior officer; whilst Major H. P. Samwell (killed in the Ardennes salient in January, 1945) relates his own experiences in *An Infantry Officer with the Eighth Army.* From New York comes Colonel Edson D. Raff's *We Jumped to Fight,* an admirable account of operations at the outset of the Tunisian campaign by the commander of a U.S. parachute battalion.

Red Patch in Sicily is a brief account of the operations of the 1st Canadian Division compiled by their own war correspondent Ross Monro. Christopher Buckley's *Road to Rome,* which starts with the landings in Sicily has been highly praised: Mr. Buckley understands the military virtues of the Germans and is not sparing of criticism regarding our handling of the Italian campaign. In *The Monastery,* F. Majdalany, an officer of the Lancashire Fusiliers, describes the part played by his battalion in the last attack on Monte Cassino, an admirable piece of descriptive writing Geraldine Edge and Mary E. Johnston, two Army nursing sisters, have written of their experiences in the hospital carrier "Leinster" during the campaigns in Sicily and Italy, calling their record of hard work and great hazards *The Ships of Youth. With the Allied Armies in Italy* is a collection of over a hundred reproductions of paintings and drawings by Edward Seago; it includes a fine portrait of Field-Marshal Alexander.

In *The Long Road to Leros* Leonard Marsland Gander describes the

British attempt to hold the island when the Germans recaptured it in 1943. He was the only war correspondent present and is now able to divulge the main facts of this " regrettable incident." From the German side comes the story of the enemy's conquest of Greece and Crete, *Kampf und Intrigue um Greichenland*, which loses nothing in the telling, by Heinz Hünger and Ernst Erich Strassi. Mr. Pendlebury, British consul, is regarded as " the Lawrence of Crete " ; there are many sneers at our military effort, and Indian troops are called " British cannon fodder," an old jibe ; illustrations, some in colour, are plentiful.

The Allied operations in Syria have not yet received much attention and Colin Kerr's *Tanks in the East*, very readable, is intended for those who, like the author, served in the 9th Australian Divisional Cavalry Regiment which went into action for the first time—equipped with obsolete tanks.

A notable book on Burma is *Burmese Outpost* by Major Anthony Irwin, a practised writer and unconventional soldier who gained experience of guerrilla warfare and was afterwards with the 7th Indian Division in Arakan. A side-light upon Burma is provided by Geoffrey Tyson who describes in *Forgotten Frontier*, published in Calcutta, the assistance rendered by the tea-planters of North-East India in evacuating the many civilians from Burma in 1942.

Cecil Beaton, still working at the behest of M.O.I. has followed his " Near East " volume with *Far East*, another collection of superb photographs admirably reproduced. He " covered " a considerable amount of fighting in Burma and China and the quality of his writing is to be commended. Jack Belden in *Still Time to Die*, a characteristic title, writes of the fighting he has witnessed in China and Burma as well as in Africa, Sicily and Italy.

It is inevitable that we see the War in the Pacific chiefly through American eyes ; but U.S. combatant officers and correspondents alike do their best to satisfy our interest and tell the whole tale of American achievement. First, however, mention may be made of *Green Armour* a record of the fighting in New Guinea and the Solomons from February, 1942 to July, 1943, based on diaries and various accounts and impressions by Osmar White, a New Zealand war correspondent. From New York comes *Carrier-War* by Lieut. Oliver Jensen who served in a U.S. aircraft-carrier at the landings at Hollandia (New Guinea) in April, 1944, in the second attack on Truk, and at the landing on Saipan. He writes well and the illustrations include coloured plates as well as many excellent photographs. The U.S. Marines appear to be their own historians : Captain H. L. Merillat covers the period August to December, 1942 in *The Island : A History of the 1st Marine Division on Guadalcanal ;* it is a real divisional history with a workmanlike account of the operations, many maps, and a list of the decorations won. *The U.S. Marines on Iwo Jima* is the work of five Marine correspondents who fought as well as wrote (they waste no words) and took many photographs. This is an *Infantry Journal* publication and is intended to be carried in the pocket. *The Epic of Tawara* by W. Richardson presents a microcosm of island warfare in the British Gilbert Group where U.S. marines obtained their objective after a few days' fighting. Another *Infantry Journal* publication is *Island Victory*, compiled by Lieut.-Colonel S. L. A. Marshall who interviewed combatants of all ranks in order to construct the story of the capture of Kwajalein Atoll (Marshall islands), an operation which obviously owed its success as much to skilful and meticulous planning as it did to gallantry and enterprise in execution. *The Pacific is My Beat*, as may be guessed from the title, is another American war reporter's book ; but Keith Wheeler is a good eye-witness and presents a vivid account of the Aleutian operations.

Here, perhaps, is the place to mention Willard Price's *The Son of Heaven : The Problem of the Mikado*, which will commend itself to those who doubted

the expediency of leaving the prestige of the Mikado unimpaired. As, however, that potentate now appears, in the language of the day, to have "debunked himself," another set of conditions has arisen.

An American book *War Below Zero*, written by three U.S. officers, describes the operations which denied Greenland to the Germans, and enabled the Allies to use the southern coast for refuelling stations and weather observation.

We may add to our knowledge of the war effort at home with *Calling All Arms*, in which Ernest Fairfax records the activities of the Nuffield factories and workshops in Oxford, Coventry and Birmingham. On a larger scale George H. Johnston writes of Australia's industrial effort in *Pacific Partner*, attempting to forecast the industrial future of the Commonwealth; he also includes his New Guinea diary which shows his countrymen at War.

The British Army by Lieut.-Colonel Graham Seton Hutchison is a stirring story written for the young—with plenty of good illustrations.

The safe-guarding of World Peace has now become the affair of the United Nations assembled in conference; but various writers continue to deal with certain aspects of the problem as they do, also, with the defence measures of the future. Lieut. Innes Hamilton, R.N., devotes *Born of Penelope* to a scheme for the federation of nations—it all comes to that—which would have as its nucleus Great Britain and the U.S.A., and ultimately embrace Germany and Japan. He certainly takes the long view. In *Peace in Our Time*, Brigadier E. G. Anstey discusses at short length the right treatment for Germany, being convinced that the German General Staff still exists and is, in secret, already planning for the next war. Despite its title Lieut.-General Sir Giffard Martel's *The Problem of Security* is chiefly interesting for its criticisms of our tank policy during the late War, the author having been at pains to enlist the opinions of junior officers who actually fought in tanks; but Sir Giffard is ready with measures which should ensure that no aggressor finds us unprepared in the future. The reprint of Lord Hankey's Lees Knowles lectures of 1945 entitled *Government Control in War* is of historical interest; for the development of our Cabinet organization is traced from the institution of the Committee of Imperial Defence up to the present day. We do not know yet how the forces which are to preserve peace in the world of the future are likely to be organized or controlled. When the scheme begins to take shape many will doubtless rush into print to commend, criticize or condemn. And when more knowledge is available concerning the potentialities of the release of atomic energy, there should be no lack of experts to explain the alterations needed in armaments, offensive and defensive, on sea and land and in the air.

To the collection of the War-time speeches of our ex-Premier can now be added a fifth volume, *The Dawn of Liberation*, covering the year 1944. Answers to questions in Parliament will be found to interrupt the flow of oratory. Mr. Churchill continues to be the most attractive subject to the biographer and *Portrait of Churchill* (i.e., as a war leader) by that experienced journalist Guy Eden has been very well received. *Winston Churchill: His Life in Pictures*, for which Ben Tucker is responsible and Sir Cuthbert Headlam has written an introduction, is attractive but by no means cheap. Malcolm Thomson's *Life and Times of Winston Churchill* devotes a fifth of its space to the war years and depends very much for its value upon its lavish illustrations. R. H. Kiernan is first in the field with a life of *Wavell*; but this is a factual record which presents no estimate of the man, the soldier and the statesman. From New York comes André Riveloup's *The Truth about De Gaulle* a whole-hearted appreciation by a French "underground" leader who criticizes severely Allied policy in North Africa in 1944.

THE 4th INDIAN DIVISIONAL ENGINEERS IN MACEDONIA

By Lieut.-Col. L. A. B. Paten, R.E.

WITHOUT respite from operations in Italy, detachments of 4th Ind. Div. started to arrive in Salonika in November, 1944. The C.R.E himself was part of a skeleton divisional staff which arrived first on 10th November. The build-up was slow, however, and H.Q., R.E., was not on the ground till 2nd December. By this date we had a theoretical strength of a Division less two Brigade Groups, but many valuable elements, including much transport and Rear Div. itself, had still not arrived and did in fact not turn up until considerably later.

During November and early December reconnaissances were pushed out as far as the Axios Plain to the west and to beyond the Struma Valley to the east. Sapper interests were focused on the two major physical obstacles, the Strimon, previously called Struma and the Axios, previously called Vardar, which set a definite limit to further expansion, and were obviously bridging problems of the first order. The Axios problem was further complicated by being the wrong side of a smaller river, the Gallikos, which in winter was not always fordable and occasionally made the main river unapproachable. There were of course many other minor demolitions on all exits from Salonika, and railways were non-existent. The weather was, however, fair, as is normal for November–December in Macedonia.

It is reasonable to say that much had been contemplated, but little had been done to open up communications when E.L.A.S. hostilities commenced in Athens in early December. Though the trouble did not have immediate repercussions in Macedonia, there was a steady deterioration in our position, and a steady narrowing of our freedom of movement, until, by 15th December, the Division was literally confined to the perimeter of Salonika itself. This state of affairs persisted, together with a steady worsening of the weather, till 17th January, 1945, when as a result of a truce with E.L.A.S. the Division expanded its patrols to a radius of about eighteen miles from the town.

This slight expansion was a signal for the commencement of serious sapper activities. The C.R.E. was, however, very handicapped by having at his disposal only the Fd. Park Coy. and the Bridging Platoon plus one Field Company, a soul-destroying wind known as the "Vardar," and a not too willing Greek population. Perhaps "not too willing" is a misleading description: labour was prepared to turn up in reasonable quantities, and was prepared to accept slightly more pay than the rules in force at the time allowed us to give, but it was definitely NOT prepared to work either in the morning or the evening or when the wind blew, which was frequently. This was not unnatural as warm clothes were scarce.

This phase continued till about the end of February, by which time, with the exception of the Axios road, all roads within our perimeter had been opened up to Class 30 traffic by the provision of bypasses and temporary Bailey bridges. Certain more permanent replacement works were also well in hand to release the scarce and therefore valuable Bailey equipment in anticipation of further expansion.

The situation on the Axios road was interesting and deserves special mention. At the time that E.L.A.S. withdrew to the truce boundary we took over from them the beginnings of work on temporary bridges over both the Axios and the Gallikos. The design had been worked out by the late P.W.D. with E.L.A.S. and, as an improvisation, could not have been improved

on by Heath Robinson himself. However, materials were not plentiful, the problem was immense, and the time factor important, as these two bridges, or the lack of them, obstructed the only route between Central Macedonia and the rest of Greece including Western Macedonia.

At Gallikos we were faced with about 800 feet of destroyed concrete bridge, the whole demolition presenting the appearance of a crazy switchback impassable by jeeps or ponies. The construction of timber trestles and a timber roadway to produce a level deck throughout was 80% completed when we took over, and the balance was finished and opened to Class 9 traffic on 28th January.

At Axios the situation was similar in that work had been commenced, but the task was very considerably greater, and only about 20% had been done: here again to avoid delay, we continued the work to the same design.

The Axios, or Vardar which is its name outside Greece, is a large perennial river rising in the snow mountains of the Central Balkans: it is subject to heavy snow spates in the spring. Though the riverbed width is only about 1,100 feet at the bridge site, the country is flat and the river is therefore further confined by outer flood banks, giving a total flood area about a mile wide. The Bridge itself covers, or did cover, 1,834 feet in 14 steel spans, each of 131 feet length, and is connected to the outer flood banks by embankments.

The demolition had excluded the first six spans on the east side, then followed four consecutive destroyed spans, the demolition being completed by the destruction of three piers. This was followed by one good span then another demolished span in the main channel, then one more good span before the fourteenth. This last span had its far end dropped by demolition of the far abutment, but did not present a serious obstacle as the near end was resting on a good pier.

E.L.A.S. had commenced reconstruction by building trestles on top of the debris of the fallen 7th span. We continued this over the 7th, 8th, 9th and 10th spans, which were then timber decked to complete the total gap of 524 feet; this was opened on 11th February for the forward movement of stores on to the sound 11th span. A 140 feet Bailey Double Single was then constructed over the 12th span and improvisations completed on the 14th span, which enabled the whole bridge to be opened for the first 3-tonner relief convoy on 14th February. (See Plate 1.)

The classification of the resultant bridge was Class 9, and Class 12 in an emergency, but this figure was not obtained from any of the known works on how to assess the form. Even the Bailey, which had the appearance of being Class 12, was in fact not more than an official Class 9, as shortage of equipment compelled us to omit some transoms and fit ramp stringers instead of the normal type.

The late Chief Engineer, Brigadier Hards, was shown the completed bridge on 17th February. At that time the river had not reached maximum spate and it was possible to walk down underneath and view the peculiar arrangement of trestles. The C.R.E. was asked whether he thought it likely that the bridge would be able to take it: there was no clue to the expected answer in the face of the Chief Engineer. The C.R.E. hazarded 50 : 50 and a silence followed: it was broken after some minutes by Daddy Hards, who remarked: "I think you are very pessimistic; in my opinion the chances are 60 : 40."

The next phase was heralded by news on 12th February that E.L.A.S. had accepted peace terms, but it was necessary for troops to remain within the truce boundary for some time after this. It was, however, possible for individual officers with special permits from General Bakerdjis, the E.L.A.S.

commander, to proceed on reconnaissances in E.L.A.S. territory from 20th February onwards, and it was also possible to move the 12 Fd. Coy. up the Polikastron road to work on an alternative route over the Axios on 26th February. Though this route involved a very long detour, it was considered to be the only place where a reliable Class 40 tank crossing might be made, as at no place lower down was the river confined between reasonably narrow banks. In spite of shocking weather, the Vardar wind being supplemented by snow for a part of the time, a Class 40 Bailey (120 feet T.S.) was constructed over the large canal, four miles south east of Polikastron, and other minor weak bridges were made good by 28th February to open the route up to a possible ferry site where the river emerges from the hills. Reconnaissances for a Class 40 ferry site followed and in spite of continued harsh weather a ferry cable was installed over the 600 feet of fast flowing river, and a ferry was ready for operation on 6th March. (See Plate 2.) At the same time the return route via Axioupolis and Goumenissa to Pella was made good, and the necessary Sherman tanks crossed over.

The month of March saw the Division steadily expand its territory. The Divisional Engineers were reinforced by the arrival of 21 Fd. Coy. from Patras, on 28th February, unfortunately less much of its transport. On 19th March, 4 Fd. Coy. moved from Velos to Kozani, and so returned to the C.R.E.'s command. Before the move of 4 Fd. Coy. there was no link road between the District of Larisa and the territory to the north which comprises Kozani, Kastoria, and Florina, the three districts of Western Macedonia. It was necessary for 4 Fd. Coy., therefore, to work its passage up, a task which included, among many other works, a 110 feet D.S. Bailey at the District Boundary (known as Boundary Bridge) and a Class 18 ferry over the Aliakmon near Servia. The Aliakmon is the largest river which lies wholly in Greece, and the complete destruction of its original bridge left a very big hole in the communications. The ferry was opened on 18th March, and with it the route from Athens to Salonika was now open to light traffic in fair weather: a first stage towards the final target of a Class 18 all weather route.

During March, 12 Fd. Coy. was further employed on raising the classification of the Florina road from Class 5 to Class 9. The work included a 100 feet Bailey near Edhessa and repairs to a number of culverts and the opening of some bypasses.

At the same time 21 Fd. Coy. was concentrated on the section of the Athens Road from Nea Khalkidhon beyond the Axios to the top of Veroia Pass at kilo 100 from Salonika, its task being to raise this road from a doubtful Class 9 to a reliable all weather Class 18. Two Bailey bridges were constructed, a 160 feet D.D. over the Loudhias and a 130 foot D.D. over the Lower Periferiaki (see Plates 3 and 4); both these were carefully "inserted" into existing gaps to give a level deck with the approaches. Work on repair of a practically impassable stretch of road from kilo 32 to kilo 37 was commenced, as was also the rebuilding of six bridges on Veroia Pass. These bridges were in replacement of unreliable Class 9 E.L.A.S. timber structures, and entailed the rebuilding of tall masonry abutments bridged by R.S.J.s and concrete decks of Class 18. The Class 2 ferry over the Aliakmon at Yidha was replaced by an improvised Class 9 ferry made from salved German Pontoons. This opened the road to Katerini to Class 9 traffic.

April found the C.R.E.'s responsibilities considerably increased without any addition of resources. The Division by steady expansion had spread out to the farthest corners of Macedonia. The area now stretched from the Turkish border, near Adrianople in the east, via the Bulgar border to near Lake Doiran in the north and on along the Yugoslav Frontier past the

THE 4TH INDIAN DIVISIONAL ENGINEERS IN MACEDONIA

TEMPORARY CROSSINGS OF THE AXIOS

Plate 1.—The completed temporary bridge.

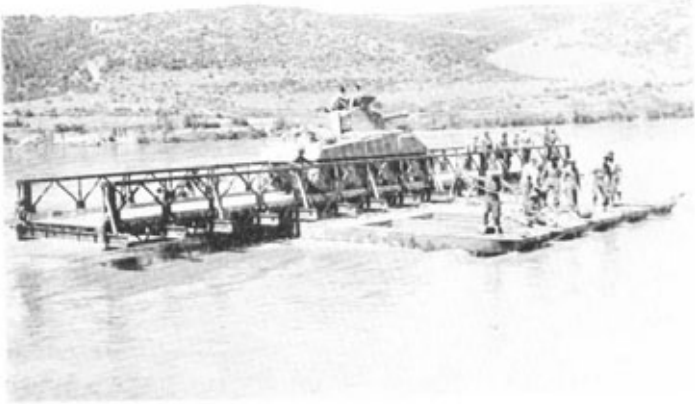


Plate 2.—Class 40 ferry at Polikastron.

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LOWER PERIFERIAKI BRIDGE

Plate 3.

Plate 4.

This bridge is of particular interest in that the 130 ft. D.D. Bailey has been "inserted" into the existing gap with only a few inches to spare and packing has been avoided by decking the second storey.

4th Indian Divisional Engineers 2

Monastir Gap; thence to Lake Prespa and along the Albanian border till it got tired and turned again eastwards to include Grevena, and so to the Ægean just north of the mouth of the Pinios.

It is admitted that there were other Engineer Troops in this area in the form of works and L. of C. units, but they were not under command and could not be persuaded to divert their efforts outside the perimeter of Salonika town itself, where they were largely concerned with port reconstruction.

It was now therefore, necessary to redispose units to deal with this wider area. Fortunately there was no essential bridge reconstruction to be done beyond the Struma, but something must be done in the way of road surfacing to relieve the traffic from the "spring-breaking" potholes which, though largely a legacy of Fritz, were rapidly getting worse under the combined heavy traffic of Divisional Maintenance and Greek Relief. To the west there was still much bridging to be done and road surfaces were no better. On April 7th the C.R.E. therefore ordered units to start gravelling the bad stretches of the more important roads and reallotted territorial responsibilities of Unit as follows:—4 Fd. Coy., with H.Q. at Kozani, the districts of Kozani, Kastoria, and Florina. 21 Fd. Coy., with H.Q. at Veroia, the centre area up to exclusive the Axios; and 12 Fd. Coy. the remainder of the area and its H.Q. to move to Kavalla later. 12 Fd. Coy's. responsibilities included the provision of heavy ferries over the Axios and the Strimon at 48 hours' notice. The Fd. Pk. Coy. and the Bridging Platoon were held back in Salonika, but were in no sense a reserve as they were in fact just as hard put to it to make ends meet as the Fd. Coys. themselves.

It was during April that Yidha bridge was reconstructed. Late in March, the G.O.C. had appreciated that the Class 9 ferry at Yidha was not adequate for the necessary relief traffic to Katerini; this particular site had previously been assessed as "unbaileyable" with our existing resources, but something must now be done about it, and the C.R.E. therefore made a personal reconnaissance. The situation was as follows:—the first pier was sound and so also was the first span of 60 feet; the second span of four heavy lattice girders supporting a sound concrete deck was resting precariously on the very edge of a partly demolished and leaning concrete pier; the third and fourth spans were not visible but presumably were somewhere in the deep and fast water of the Aliakmon; the third pier was also not to be found above water level; on the far bank the fifth span was resting on a sound fourth pier. The second pier and span were obviously not a good enough support for a Bailey, but if they were demolished the resultant gap would be 180 feet, and that would require more Bailey than we possessed or were likely to be able to get. It was, therefore, essential to make use of the existing second span. Work was commenced on 1st April; the concrete deck of the second span was demolished and the steelwork was then hung on the end of a Double Double Bailey Cantilever which had been rolled out across the first pier. The steelwork was then raised, the second pier demolished down to slightly below water level and rebuilt in mass concrete up to its original height. The second span was lowered into position on new bearings, and the Bailey Cantilever dismantled and taken by ferry to the far bank, where construction of the required 120 foot T.S. Bailey was commenced with rollers on the far side of pier four. At the same time the second span was redecked with reinforced concrete. The new Bailey was then launched and "inserted" in the gap between piers two and four to give a level deck. The new bridge was opened to Class 18 traffic on 30th April. (See Plates 5 and 6.)

Further steady progress was made on all roads during May, all units working full out without thought of relief. In the west, 4 Fd. Coy. opened

up a circular route from near Siatista (on the Kozani–Grevena road) northwards through Argos Orestikon to Kastoria, thence on over the pass to the Upper Aliakmon valley, via Gavros, to Andartikon, and so over the high pass to Florina. From Florina southwards to Kozani the main road was patched up with gravel throughout and low class culverts and minor bridges were repaired, rebuilt or bypassed to make the whole route Class 18 and more or less all weather.

On Veroia Pass 21 Fd. Coy. continued work on the six new minor bridges, and four were completed and opened to traffic on 10th May; the remaining two were situated at most awkward sites, necessitating the use of temporary Bailey bridges and the rebuilding of twenty foot high abutments beneath; the new decks had to be cast through the decks of the temporary Bailey bridges without interruption to traffic; both these works were completed at the end of the following month.

In early May, information was received from Headquarters that additional bridging equipment was to be made available and preparations were made to plan for its use. A list of requirements was submitted to the Chief Engineer, and on 15th May allotments of new equipment were made which covered a large part of our demand. Briefly, the programme included 510 feet of Bailey for a new bridge to replace the Class 18 ferry at Servia, where the main Athens road crosses the Aliakmon; 330 feet and 200 feet of Flambo* to rebuild Upper Periferiaki and Balitsis Bridges to raise the Edhessa road to Class 18; 530 feet of Bailey to replace the temporary structure in the main gap of Axios Bridge; and about 420 feet of Bailey for the crossing of the Upper Strimon at Strimonikon. In addition to these major projects sufficient Flambo would also be available for about six other minor bridges, including Boundary Bridge to the south of Servia and two more bridges on the Edhessa road. Nearly all these bridges required preparatory work on demolished piers and abutments, and in anticipation of sanction, work was commenced accordingly.

On 1st June we ceased paying civil labour in accordance with orders from H.Q., which stated that P.W.D. funds, both for road maintenance and minor bridge building, were on the way. As a policy, we were to assist with all available transport as before, and give all possible encouragement and assistance to the P.W.D., but further expenditure of W.D. money was to cease. Alas, the hoped for action by the P.W.D. turned out to be unjustified; firstly there was delay in the making of allotments by the Central Government; then followed further delay in the making available of the necessary credits at local banks; then followed, in spite of our encouragement to get contracts let and ready beforehand, a further delay in getting contractors to start work. Meanwhile our transport and machines and the few steam rollers which we had assisted in putting into working order, lay largely idle through the month of June. The gravelling maintenance of roads which we had so effectively commenced was largely at a standstill, and the heavy traffic was rapidly reducing the roads to their original shocking state. In fact, from this point of view June was a most depressing and disheartening month.

It was in June, however, that a bright star appeared on the horizon; 20 G.H.Q. Troops Engineers were to be moved to Salonika and would take over all engineer work from inclusive the Axios to the Turkish border. Plans were, therefore, made accordingly for the relief of 12 Fd. Coy.; there was, however, more delay than was expected and it was not till early July that the relief actually took place and allowed the C.R.E. to withdraw 12 Fd. Coy. to a rest and training camp by the sea. Meanwhile we made certain that on one, at least, of the two new bridges due to be built in this area, the relief unit should

* Flambo is a modified form of Bailey, made locally, using mild steel.

YIDHA BRIDGE

OVER THE LOWER ALIAKMON

Plate 5.

A general view of the bridge during reconstruction.

Plate 6.

The completed bridge : Second span lowered onto new second pier and concrete decked : 120 foot Bailey bridging the gap from pier two to pier four.

Plate 7.—WILLIE'S BRIDGE
A totally new structure on the Athens road.

Plate 8.—ASVESTOKHORION BRIDGE
Abutments rebuilt from foundations upwards. Centre pier added and gap spanned by R.S.J.s and concrete.

get a fair start; during the latter half of June, 12 Fd. Coy. practically completed the demolition of all old concrete piers and spans which obstructed the site of the new bridge over the Strimon at Strimonikon, and a clear site was handed over on 3rd July.

Towards the end of June the south abutment of Servia bridge was completed, and also the patching and recapping of the two centre piers, and a start was made on despatching all available spare Bailey to the site from Salonika. By 25th June the south approach had been bulldozed clear, and launching and construction rollers had been placed in readiness for launching, which was commenced on 26th June. By the time that the new consignment of Bailey was off-loaded from ship in Salonika on 11th July, the utilization of the last available panel of spare Bailey had enabled about half of the new bridge to be built. From 12th July onwards convoys of new equipment proceeded out to the site, and by 17th July the launching nose had reached its destination on the north abutment. The whole 510 feet of "Double Double" was safely across by 19th July.

Meanwhile the Field Park, as always quietly and efficiently in support, had worked flat out on building up the necessary "specials" required to support the bridge over the two piers. As usual an improvisation was necessary as the eight crib bearings which were demanded, and which were expected to be included in the Bailey ship, were not found. The "specials" were, however, completed and despatched on 21st July, which enabled "jacking down" to be commenced the following day.

This fine bridge of three clear spans of 170 feet each was decked and opened to traffic on 31st July; it was appropriately renamed "Red Eagle Bridge." Thus was forged the last-but-one major link in the Macedonian section of the Class 18 route to Athens. At the same time, about twenty miles to the south, a new Flambo bridge was being built on the heavy masonry abutments which for the last six weeks had been under construction beneath the temporary Bailey at Boundary Bridge; a minor though important link in the same chain.

On the Salonika—Edhessa—Florina road, 21 Fd. Coy. were working on the rebuilding of the two major bridges, the Upper Periferiaki and the Balitsis, which in accordance with the new programme were to be bridged with Flambo.

The Periferiaki is a large land reclamation canal, and at the time of our arrival was bridged by a temporary Class 9 timber bridge situated beside the wreckage of an unfinished concrete bridge. The work to be done consisted in making good the embankment approach to both abutments; the demolition of one damaged concrete span which was lying upended against the sixth pier; the demolition of piers two, five and six which were cracked and leaning, and the rebuilding of these, plus pier number seven, in reinforced concrete. Finally the placing of about 330 feet of Flambo over the eight spans; the Flambo to be concrete decked to complete the bridge. By the time the P.W.D. contractor was ready to take over work on 20th July, we had completed both abutment fillings, demolished all three damaged piers and rebuilt pier number two. In accordance with instructions from H.Q. we then withdrew sapper labour, less that required for operation of transport and machines which we continued to supply in support of the contractor.

At Balitsis the situation was slightly different: the old concrete bridge had been effectively wrecked and a temporary Class 9 timber trestle structure, two hundred feet long, had been superimposed on the wreckage. Here, therefore, it was necessary to provide a bypass for traffic to enable the old bridge to be cleared and rebuilt. By 20th July the bypass, a temporary Bailey, had been opened, and the old concrete was about 70% cleared and the centre of

three necessary piers was ready for excavation and rebuilding. At this stage we handed over this work also to the P.W.D. contractor, continuing to give support with transport and plant.

It was hoped these two bridge sites would both be ready for the placing of Flambo bridge by early October when the Sappers would return and complete their task.

Photographs of two of the permanent bridges constructed are given in Plates 7 and 8.

This record would be incomplete without mentioning certain factors which had a direct bearing on the results it was possible to achieve in the time and with the resources at our disposal. The shortage of Bailey equipment and mechanical plant was one such factor.

Secondly, there was scarcely a bridge site which was not mined, and camp sites nearby were also suspect. In one case a most harmless-looking site, remote from any bridge, cost us one of our two valuable D.4 Bulldozers on a 1 kilo. German prepared charge fitted with a D.Z. 35 igniter: a further search of this site revealed about twenty more similar traps.

Thirdly, the extreme severity of the winter in the early stages, grim though it was, constituted but a minor check on efficiency when compared with the anti-malarial precautions which in the later stages of nearly all work prevented any unit, or even a small party, from camping at the site of its work. In some cases camps had to be placed upwards of twenty miles from the job.

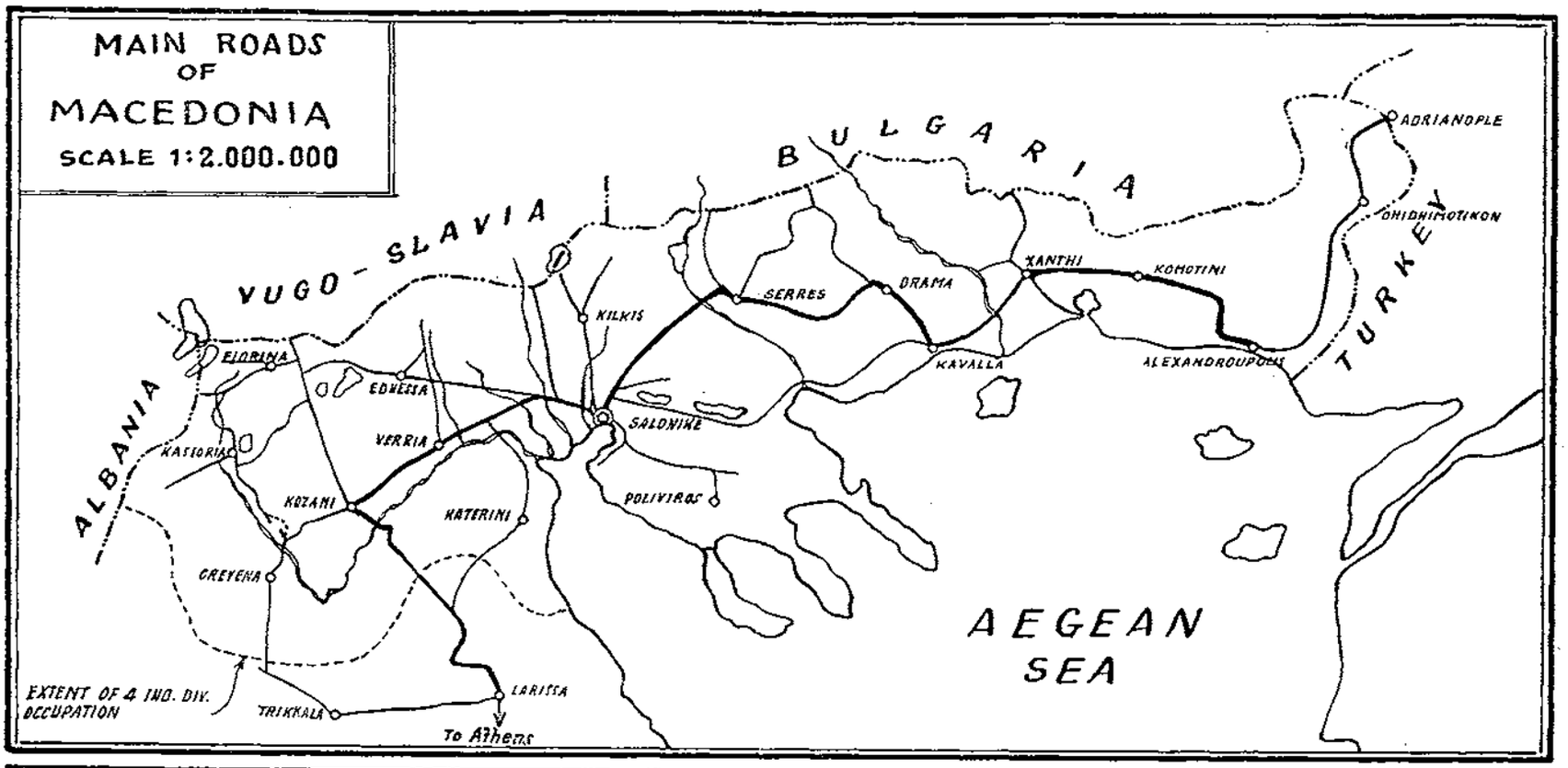
Lastly, it must be remembered that the 4th Indian Divisional Engineers had been trained and used almost continuously in an operational role, and its personnel were, therefore, quite unfamiliar with, and untrained in, the building of permanent and semi-permanent bridges which formed such a large part of our work in Macedonia.

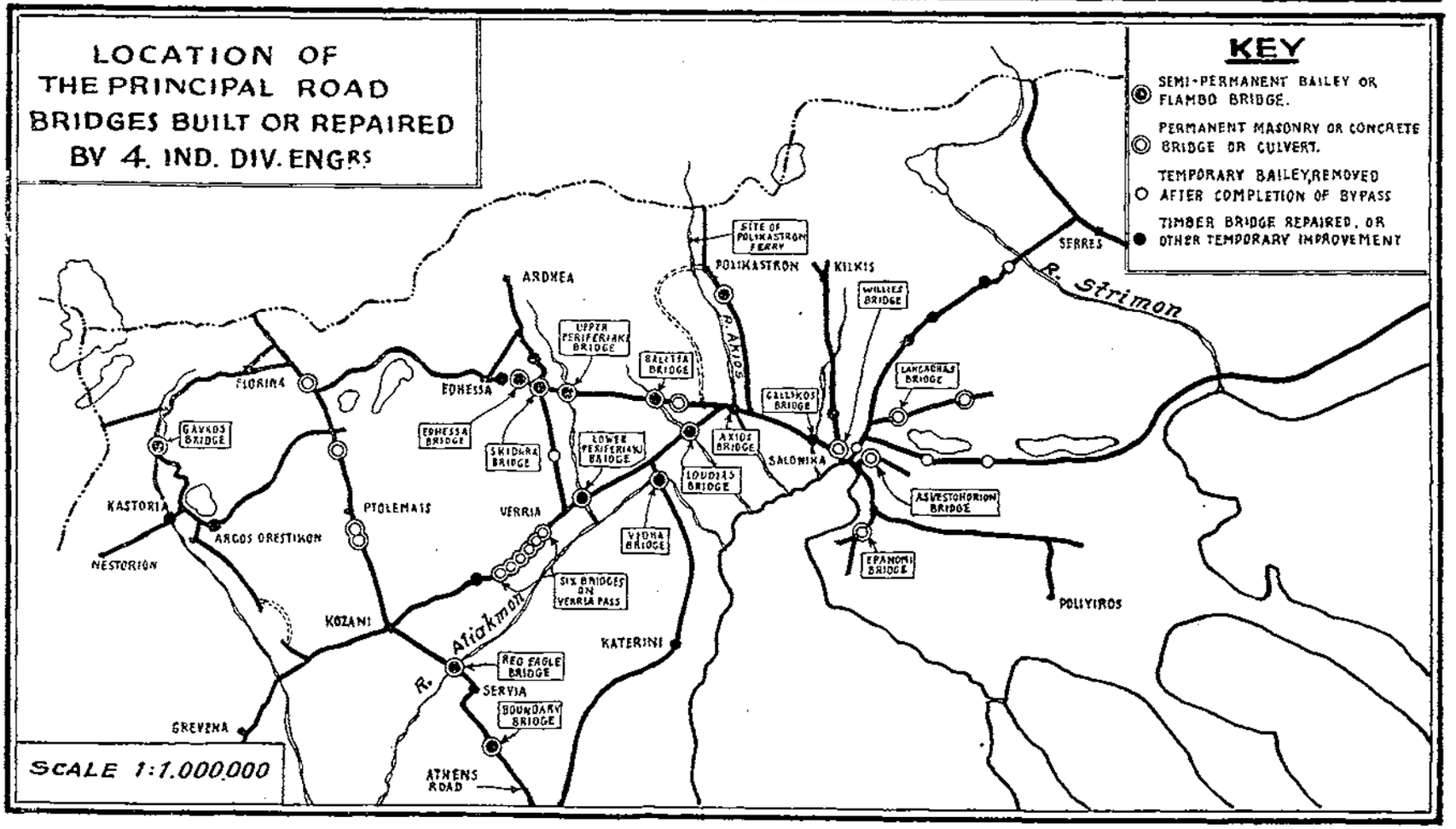
In conclusion, the Sapper and Miner units concerned can be justly proud of their achievements in this new role: these achievements have been made possible largely by the fine spirit and determination of all ranks to see the job through in the face of considerable difficulties.

APPENDIX "A."

SUMMARY OF BRIDGES BUILT AND REPAIRED BY 4th IND. DIV. IN MACEDONIA.

	Number	Total Foot Run
A.—Permanent Structures in Masonry or Concrete..	15	398
B.—Temporary Timber Bridges	5	996
C.—Temporary Bailey Bridges (since taken up)	13	1,000
D.—Semi-Permanent Bailey Bridges.. ..	5	1,040
E.—Semi-Permanent Flambo Bridges (due to be completed)	6	844
TOTAL ..	44	4,278


MAIN ROADS
OF
MACEDONIA
SCALE 1:2.000.000
BULGARIA
YUGO-SLAVIA
ALBANIA
TURKEY
ADRIANOPLE
DHIDHIMOTIKON
XANTHI
KOMOTINI
SERRES
DRAMA
KAVALLA
ALEXANDROUPOLIS
KILKIS
FLORINA
EDHESSA
VERRIA
SALONIKA
KASTORIA
KOZANI
KATERINI
POLIYIROS
GREVENA
AEGEAN
SEA
EXTENT OF 4 IND. DIV. OCCUPATION
TRIKKALA
LARISSA
To Athens


LOCATION OF
THE PRINCIPAL ROAD
BRIDGES BUILT OR REPAIRED
BY 4. IND. DIV. ENGRS
KEY
SEMI-PERMANENT BAILEY OR FLAMBO BRIDGE.
PERMANENT MASONRY OR CONCRETE BRIDGE OR CULVERT.
TEMPORARY BAILEY, REMOVED AFTER COMPLETION OF BYPASS
TIMBER BRIDGE REPAIRED, OR OTHER TEMPORARY IMPROVEMENT
SITE OF POLYKASTRON FERRY
POLYKASTRON
KILKIS
SERRES
R. Strimon
ARDHEA
R. AXIOS
WILLIES BRIDGE
UPPER PERIFERIAKI BRIDGE
BALESTA BRIDGE
LANGADHAS BRIDGE
GALLIKOS BRIDGE
FLORINA
EDHESSA
GAVKOS BRIDGE
EDHESSA BRIDGE
SKIDHRA BRIDGE
LOWER PERIFERIAKI BRIDGE
AXIOS BRIDGE
LOUDIAS BRIDGE
SALONIKA
ASVESTOHORION BRIDGE
KASTORIA
PTOLEMAIS
VERRIA
ARGOS ORESTIKON
VIDNA BRIDGE
NESTORION
SIX BRIDGES ON VERRIA PASS
EPANOMI BRIDGE
POLIYIROS
KOZANI
Aliakmon
KATERINI
R.
RED EAGLE BRIDGE
SERVIA
BOUNDARY BRIDGE
GREVENA
ATHENS ROAD
SCALE 1:1.000.000

SAPPERS IN SOUTHERN LATITUDES

By Capt. R. Vickers Todd, R.E.

TO many people there exists nothing of importance between the Southern tip of South America and that vague continent of Antarctica in which lies the South Pole. The Battle of the Falkland Islands, which ended in disaster for the German Pacific fleet during the last war, recalls to mind those two small islands that act as a Malta to the Magellan Straits and the seat of government to a vast area of the Southern Hemisphere, bounded by longitudes 10° E. and 110° W. and latitude 50° S., enclosing some of the world's richest whaling fields. Before the Panama Canal was cut, shipping from the 7,000 miles of Western American seaboard had to pass through the stormbound tortuous channels of the Estrecho de Magellanes, or battle against the elements rounding Cape Horn, before reaching the welcome shelter of the Falklands' several harbours.

Had the enemy succeeded in blocking the Panama Canal vast quantities of minerals mined in Chile, Peru, Bolivia and the Western states of North America would have to have been shipped down the fatiguing route to the Falklands, where the ships would re-fuel and re-victual. Hence as a supply station and naval base for warships policing that alternative route, the islands had to be given a certain degree of self-protection. 727 General Construction Company R.E. was detailed to carry out the fortification and engineering work involved, and in April, 1942, Major J. D. Beresford, M.C., R.E., the Company Commander, prepared schedules of special stores, tools and equipment that would be required to see the job through. As there was little detailed topographical information available every eventuality had to be catered for, bearing in mind that our nearest source of supply would be nearly 1,200 miles away in a neutral country.

The advance engineer party comprising 4 officers and 180 other ranks under the command of the author left Berkshire for Birkenhead on the 19th of May. The remainder of the unit was to follow in the company of the garrisoning units in one month's time. Full scales of arctic, tropical and home service clothing and equipment were carried and during the course of time all were very much needed.

Security was good, only the officers knowing of their destination, but this state of affairs was short lived when a number of large cases labelled N.O.I.C., Falkland Islands, were loaded aboard in full view of dock and military personnel.

The Force Commander and his staff, together with a small advance party from each garrisoning unit, travelled in the 10,000 ton transport. Our first port of call was Freetown, where for a week we tolerated the burning decks and slashing rainstorms. Our naval escort was left at Freetown and at a maximum speed of 12 knots we travelled alone across the South Atlantic which behaved as only the South Atlantic can behave. During this part of the voyage, however, we were not idle; at every opportunity the sappers were given practical training in the use of the ship's steam derricks, winches and in the rigging of various types of nautical lifting tackle, all of which proved invaluable when we discharged the cargo at Port Stanley. The maps of the islands contained very limited information and were not blessed with a grid, so necessary for military operations, thus another task for the Engineers was to place a 500 km. grid square over the area in order to facilitate the preplanning of the defences, and it was not until a Survey Section arrived at

Port Stanley six months later that maps gridded on the world grid were made available.

Nearly seven weeks after embarkation the much buffetted *Strategist* anchored in Port William, a mile from the two Class 3 wooden jetties where three small boys braved the cold drizzle to give a civic reception to the travel weary troops that disembarked from converted lighters.

Working a twelve-hour day for three weeks those 180 sappers discharged the very mixed cargo, built covered storage, and formed dumps, and commenced construction of cooking, dining, and sanitary accommodation for over 2,000 troops. Though aided by some of the crew and a handful of civilians, the cargo discharge presented many new problems to personnel in a General Construction Company. High winds and rough seas made lighterage a far from easy task. The 30 cwt. jib on the F.I.C. jetty was soon out of action and the P.W.D. jetty sank nearly an inch a day under our 4 and 5 ton loads. Whenever possible the decks of a shallow draught oil tanker were used for lightering, and the 50 ton whaler borrowed by O.C.R.E. did heavier work than she did when towing whales to South Georgia. In spite of weather that had all the unpleasant characteristics experienced in Iceland or the Shetlands, the work pushed ahead and was completed a week before the scheduled arrival of the main force. And as we watched the friendly " factory funnelled " *Strategist* churning its way toward Montevideo we realised the true meaning of " turning the ships round."

After the main body of troops had been billeted in the town's 250 odd houses the work of construction began in earnest and improvisation was the order of the day. From our quarry we crushed aggregate or collected and crushed the smooth round boulders from the many " rivers of stone," termed by Darwin as one of the geological phenomena of the world ; shore sands were used in everything from concrete piles to concrete pipes, whilst the clear water from lakes in the rocky hills was passed through sand filters to supply the camp systems. Apart from a few stunted trees there was no standing timber on the islands, thus, having exhausted our supply from U.K. we had to obtain Parana pine from Punta Arenas or Uruguay, shipped by the 600 ton *Fitzroy*, which was our only physical connection with the outer world. Electricity was generated by four 75 kw. high speed G.M.C. diesel sets, which proved highly efficient and trouble free, a neater and more compact generating set would have been hard to find. When most of the ancillary construction, including abattoir, churches, theatre and stables, was completed, work was commenced on a new tubular steel, Class 5, military jetty and the repairing of the well worn F.I.C. and P.W.D. jetties.

Although provision had been made for many emergencies before leaving England, the planning of defences was considerably handicapped by lack of detailed topographical information which necessitated long surveys by Engineers of uncharted mountains, rivers and coastal indentations. The great areas of peat bog, rock outcrop and soft ground seriously handicapped all vehicular movement, jeeps being the only transport that could safely cross the island. Seldom did an exercise take place without 25% of the vehicles getting bogged, and, once the surface of the peat was broken, as many as eight carriers were needed to haul from its slimy berth a single unfortunate vehicle. When it was necessary to move a 6 in. naval gun from one site to another, 2 miles across country, four teams, each of 200 men, were needed to haul the loaded sledge over the soft ground, and the sight of the battalion adjutant astride the barrel, complete with megaphone and " whip," directing these 800 men, recalled scenes of Cheops hauling stone for the construction of his pyramids.

It was on the 20th January, 1943, that the author was told to produce a

number of Union Jacks and masts that would withstand the Antarctic weather, so working within a guarded E.B.W., the blacksmiths produced and crated the stores ready for disposal. During a Force Commander's conference a party was detailed to carry out a reconnaissance of the South Shetlands and South Orkney islands. Greatest secrecy had to be maintained, and the party was to consist of the D.A.Q.M.G., a naval interpreter, Major Greenshield, A.D.C., Dr. Hamilton, F.R.Z.S., Polar Medallist, and the author as engineer adviser. For five days the party awaited the arrival of H.M.S., A.M.C. *Caernarvon Castle*. In the grey morning of the 25th the cruiser arrived in Port William, and once aboard, the party was briefed for its mission.

As the only Sapper officer, it was the author's role to make an engineer tactical reconnaissance of such territory on which it was possible to land, to obtain such information as could be used in deciding whether troops could be stationed there for any length of time, and lastly to physically re-affirm, by the planting of the British flag, that that territory enclosed by certain lines of longitude and latitude was British Crown property.

In order to be acquainted with all available geological, topographical and historical information of the territory before reaching our destination, careful and lengthy perusal was made of such books as Dr. Charcot's *Expedition to the South, 1905*, and *The Discovery II. Expedition, 1929-1931*, and the latest naval charts. Leaving Port Stanley early on the morning of the 26th, we proceeded in S.S.W. direction towards the South Orkneys at a speed of 12–14 knots, but at noon on the 27th a signal was received directing our course to the South Shetlands.

As it was mid-summer in these latitudes it was a little disappointing to see the mercury well above the Fahrenheit zero, but from the morning of the 28th our duffle coats and leather jackets were really needed. Several icebergs were passed, and one distant giant, estimated to be 10 miles in length of 200 feet high, scintillated pastel shades of emerald and turquoise from its caverns and cliffs. This floating island of ice was thought by Dr. Hamilton to have broken off the great Wilhelm Barrier. On drift ice, penguins could be seen diving for fish and emitting their puppylike bark, whilst schools of fin whales were sighted blowing in the distance with a faint snoring noise. At this latitude there is very little darkness during the summer months, and no interesting aurora australis were to be seen on the voyage.

Our first sight of land was on the 29th when the ice cliffs of Smith Island appeared in the south-east, but upon closer examination it was found impossible to make a landing so we moved out into the Boyd Straits for the night's shelter and from whence we should sail to Deception Island in the morning. Deception Island was approached in the early morning of the 30th, and the vividly coloured volcanic rocks and cliffs made a sharp contrast against the snow covered hills. This island was once an active volcano and not many centuries ago erupted with such force that a gap was blown on the side of the crater, allowing the sea to pour in, thus forming a landlocked harbour of some ten square miles which is surrounded by a snow-capped annular ridge rising to 1,000 feet above sea level. Volcanic rock and ash, upon which not even the lowest form of vegetation can grow, formed the crust of the island, which owing to its volcanic nature has a ground temperature 15° higher than that of any adjacent island. This fact causes the summer snowline to retreat to 100 ft. above sea level, and because of its seasonal freedom from permanent snows it has been used as a base for many Antarctic expeditions and a centre for the surrounding whaling fields.

The entrance to the bay was not more than 250 feet wide, and the jagged volcanic cliffs rose vertically from the sea to a height of several hundred feet,

giving the channel a canyon-like appearance. The cruiser hove to, and a picket boat made a reconnaissance of the channel, cautiously venturing into the bay as if expecting to find an enemy base established there. Finding that all was clear, the big ship was guided into the bay to anchor. Our party, the senior naval officers and some naval ratings, landed on the ash covered shore and proceeded on a preliminary survey of the whaling station that was established a few hundred feet from the water line. The cutter loaded with our stores was beached and the working party prepared for action. The whaling station comprised of living accommodation for two hundred men, a small hospital, offices, stores, a large wooden flensing platform upon which whales were "diced," a batch of boiling pans heated by diesel oil, whale oil barrelling sheds, and storage tanks for about 4,000 tons of gas oil. All the buildings were of timber construction with felt roofs, and, though the winter snows of the past four years had wrecked many of them, the material was in an excellent state of preservation, due to the refrigeration process of the snow.

The hospital had had its windows blown out and the building was filled solid with frozen snow, and upon excavating into a room marked dispensary we discovered large quantities of medical stores, mostly used for treating the very serious cuts and fractures which are so frequent in whaling operations.

Having made our preliminary survey, a more serious matter confronted us. The flag of Argentina was flying from a mast, and a very neatly stamped brass plaque told us in no uncertain terms that Argentina intended to classify the territory around us as her national asset. So with due ceremony the flag of Argentina was removed, the plaque unscrewed from the mast and some markings in paint on the oil tanks obliterated. Feeling sure that there would be a more formal indication of the annexation by Argentina, the treasure hunt began; every likely place was searched, and espying a length of thin brass wire fastened to the base of mast, the author culminated the chase by exposing a watertight cylinder which had been buried 18 in. below ground. This tube was found to contain a formal declaration of ownership by the Argentine and was signed by several persons in high authority.

But too much time had already been spent on things other than the reconnaissance and with a party of ratings to assist, all possible information of the island was obtained. Never had a camera proved more useful in those latitudes, and armed with many measurements, samples and specimens the party returned to the cruiser, from whose bridge Capt. Kitson, R.N., apprehensively kept one eye on the ice floes crowding near the harbour's bottleneck and the other on a falling barometer.

We sailed through the thickening brash ice into Bransfield Strait, and looked back to see the British flag swinging in the rising wind as if proud to be the southernmost flag in the world. As we proceeded toward Adelaide Islands there was ample time to compile reports, develop photographs and classify specimens and samples, for the thermometer was showing between 20 and 30 degrees of frost and snowstorms prevented visual navigation. Floe ice necessitated many breaks in our journey, for a ten ton block of ice would do a lot of damage to a screw, and though R.D.F. was invaluable in locating islands and icebergs it was of little use against slab ice, through which the 20,000 ton cruiser had to pass. But not all the ice in the Antarctic could cool the author's brow as he thought of the naval rating, who, on the previous day, had pierced a 10 kg. tin of gunpowder with a pickaxe, saying as the black granules poured out of the jagged hole, "this is funny stuff, sir." A later test of this powder revealed that it was in first-class condition and could fire many an explosive harpoon shell into a whale at 100 yards' range.

During the period 30th January to 6th February, we had traversed the

fringe of Graham Land as far as Adelaide Islands then turned north, passing Livingstone Island on the way across to the South Orkneys Group. The weather was severe and again our R.D.F. proved its great usefulness. It had been impossible to land on any of the islands and ice bound shores ruled out the possibility of any habitation existing farther inland. Many schools of whales were seen, and flocks of penguins abounded the perimeter of island and the caps of smaller icebergs. At 0800 on the 6th of February the cruiser arrived at the South Orkneys Group, but it was found impossible to anchor owing to the possibility of icebergs fouling the cables, and so, after encircling the group, the cruiser put out into the Washington Strait which formed a fairly ice free shelter. On the 7th another effort was made to make a landing at Coronation Island, but, as there was a likelihood of being blockaded in the harbour, it was decided to remain in the Straits for another 24 hours.

With the weather cold and clear and the channel free of ice, the cruiser proceeded to Signy Island where a favourable anchorage was made. To all appearances the small whaling station on the island had been vacated some ten years ago, but, apart from damage by ice and heavy snow, materials were in good condition; a reservoir with pumphouse and 3 in. pipeline to a small landing stage indicated that it had been used as a watering point for whalers or floating factories. At one side of the island was a stack of prefabricated sections of wooden hutting, giving the manufacturer's name and his address in Riga, Latvia, and dated 1929. Several rolls of Ruberoid roofing felt made in England lay beside the stack in apparently good condition. To say that Signy Island was not inhabited would be incorrect, for its population consisted of herds of sea elephants, sea lions with a sprinkling of sea leopards and seals. All types of bird life abounded, whilst many varieties of penguins stood goggling in awe at the invading bipeds. To those who have not seen a sea elephant in his natural element, a picture of a slug, weighing up to two tons and covered in his own excreta, will convey a true impression of its appearance and odour.

In two places on this island the British flag was planted before embarking aboard the cruiser, and whilst proceeding to Laurie Island we compiled our reports and developed our photographs. Some years ago the British Government had permitted the Argentina to operate a meteorological station on Laurie Island, for it had been proved that whatever type of weather was experienced in that area the same weather in a mild form would occur in the centre of South America three and a half years later, thus due warning could be given to ranchers and farmers of pending drought and storm. The Met. personnel at this station are relieved annually, thus it was amusing to see their expressions when they awoke at 0930 to find a group of British officers at their door and a huge A.M.C. anchored in the bay, for their reliefs were due to arrive in a destroyer within a week, so they must have been rather disappointed to find us only visitors. Our inspection of the Met. station was done with a thoroughness, limited only by diplomatic discretion, and though our gifts of eggs and butter, etc., were very warmly received by our hosts at the time, they patriotically signalled to their Buenos Ayres H.Q. telling of our intrusion and of our persistence in offering them stores of food. Perhaps it was as well that we did not meet the destroyer bringing their reliefs.

With a course to the N.W. we made good speed through rain and snow to Port Stanley, and upon reaching our berth were royally entertained by H.E. Sir Wolsey Cardinall, K.B.E., C.M.G., Governor of Falkland Islands Dependency, and in due course the " evidence " of Argentina's annexation was crated and sent to higher authorities for " filing." Though little has been said of actual reconnaissance, it was found that accommodation

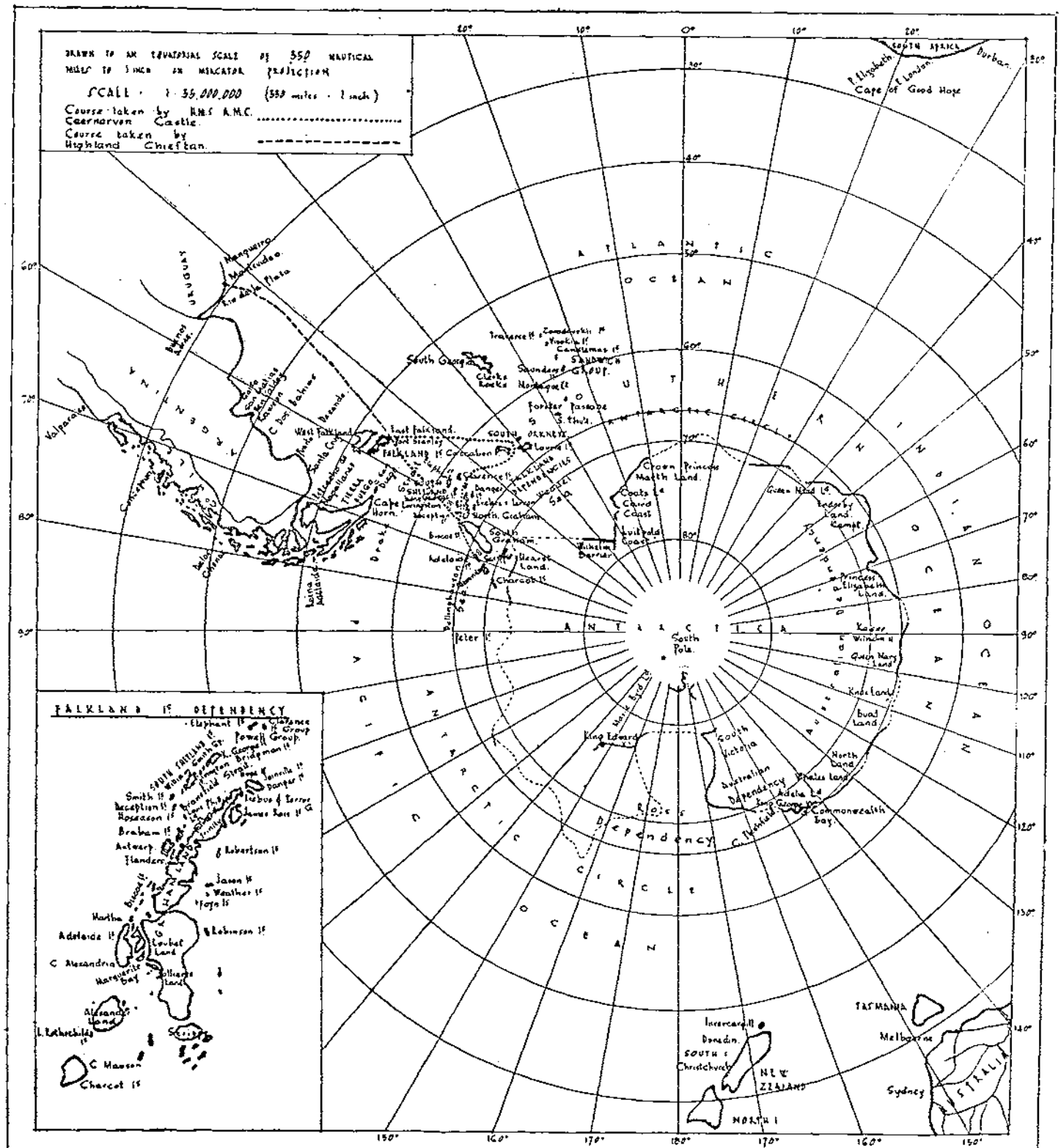
could be constructed, and troops could exist on those islands we visited but their maximum tour should not exceed 12 months at a time, and in event of food supplies failing, the animal bird life could provide them with sustenance and fuel.

This article would not be complete if it were to finish without a record of the events which befell the unit *en route* to England. For after leaving Port Stanley in May, 1943, aboard the refrigerated motor-ship *Highland Chieftain*, nearly three weeks were to be spent by the company in the capital city of Uruguay whilst the ship was loaded with meat. Thus the Royal Engineers had the privilege of providing the largest unit of the British Forces ever to set foot in Uruguay since the early nineteenth century, when Admiral Lord Beresford retreated through the country after his unfruitful attempt to capture Buenos Ayres. It was impossible to express fully our gratitude for the overwhelming hospitality and generosity of the very pro-British Uruguayans. Never a peon did we pass but he gave the victory sign and the cheer of "Viva Inglesa," whilst the produce of every vineyard and hopfield seemed to be placed at the disposal of Tropas Britannacas.

Whilst South American power stations were generating current on a mixture of grain and oil, and railway engines were fuelled on cabracho logs, the C.U.R. saved up oil to enable two special trains to take the unit up country to see the historic town of Minas. Messrs. Swifts, after providing the company with an unbelievable asardo,* showed us how Britain obtained its pressed beef and dehydrated meats by a four-hour tour of their huge plant. "Going in with the cows and coming out with the cans" was most revealing, and seeing those thousands of crates stencilled with shamock sign and S.R.D. being loaded into lighters for North Africa, we realized the war effort this small thrifty country was making.

The unofficial entry of the Royal Engineers into Montevideo was such that the Argentina and Bolivian newspapers devoted sections of their picture pages to those Tropas Britannacas marching through streets lined with cheering people, but their editorials hinted at things other than non-belligerency. As our stay coincided with Uruguay's National Day of Independency, the company was privileged with a special position in the annual parade; and the wreath laid by Major J. D. Beresford at the foot of the Liberator's statue was meant as more than respect to General Artigas, and was so acknowledged by the country's Vice-President when he received our salute.

* A picnic meal under eucalyptus trees and consisting of suckling pigs, fowl and beef, roasted on the spit, served with salads, wine and numerous Spanish delicacies.



SOUTH POLAR REGIONS.

TWENTY YEARS IN THE DEVELOPMENT OF MILITARY ROAD BRIDGING
(1925 to 1945)

By Col. S. A. Stewart.

GREAT BRITAIN has always gone to war unprepared, and although the recent war was no exception there was nevertheless a greater pre-war period than usual during which the army expanded and financial stringency on development of equipment was lifted.

R.E. equipment, and particularly bridging, is closely governed by the state of mechanization of the remainder of the army and is directly affected by the size and weight of its tanks. The latter naturally are involved in the perpetual race between armour and anti-tank guns, and during the period when war begins to appear imminent their weight tends to rise during production to combat the latest known development of the weapons of potential enemies. The bridge designer follows behind, faint but pursuing.

Before the impetus of the last war had died away the army had been re-equipped with the Mark 4 Pontoon Equipment which went into service in 1925. This could be used to make " medium " bridge (9 tons) or " heavy " bridge (19 tons). Many sappers will remember the discomforts of carrying the new 260 lb. steel roadbearers with four men and the thoughts that they much preferred the old wooden equipment (capacity G.S. Wagons). For light loads the Folding Boat Equipment (F.B.E.) of 5 tons capacity was adopted in 1928, and the Small Box Girder (S.B.G.) shortly after. These three equipments, together with the Kapok Assault Bridge and the Martel Box Girder, which was designed by Major (now General) Martel shortly after the last war, represented the entire bridging resources of the army up till 1937. During this period the heaviest tank in the service was the Vickers Medium, weighing about 12 tons, so that there was ample margin of carrying capacity in the heavy pontoon bridge. Erection of this bridge was incidentally regarded as a major operation, and one which was unlikely to be completed within about two to three days of the assault.

Between 1929 and 1936 the army experienced its leanest period, during which all things military were out of favour and almost no development work took place. Practically no tanks existed, the majority of those that did were " light," weighing under 5 tons, armoured to stop a rifle bullet and no more. The Experimental Bridging Establishment, at which all R.E. road bridging equipment was developed, was reduced to a strength of one R.E. officer, one civilian engineer (Mr. D. C. Bailey* of whom more later), one draughtsman, and a workshop of fourteen men. There was even a considerable file at one time on the subject that the retention of Mr. Bailey could no longer be justified, but this fortunately did not quite reach finality.

In 1937 war clouds were gathering and people began to realize that we had a small out-of-date army with practically no equipment. The financial brake was released and instead, any reasonable request for personnel or plant for experimental purposes began to be granted with alacrity. The tactics of river crossing were at the same time being reviewed in the light of developments in

* Now Sir Donald Bailey, Kt., O.B.E.

tanks and automatic weapons, and the changes in these tactics began to be reflected in demands for new equipment.

The first change was brought about by the growing power and number of machine guns, which ruled out the Kapok bridge as a means of getting the first waves of infantry across rivers. Instead some form of boat was required. A somewhat amusing regatta was therefore held at E.B.E. at which some seventeen types of craft (commercial and otherwise) were demonstrated before G.S. representatives. These craft ranged from the ordinary Lilo mattress—very portable but very unsafe—to a boat which could be carried in a haversack, but which consisted of 37 parts and which took a skilled man an hour to assemble at the water's edge. The winner of this regatta was a boat invented by Mr. Goatley of Saunders Roe, which arrived on a lorry five minutes before the end of the demonstration just in time to become the Assault Boat, Mark 1. The Recce Boat was also selected at this regatta—this was a commercial bathing boat slightly modified.

The next event was the development of the Matilda tank, which started at 23 tons but which gradually crept up to 26 tons in the approved style before going into production. Revised tactics required that this should be able to cross rivers as soon after the assault as possible, and the new pontoon equipment on the " raft " system was therefore developed concurrently, the design unfortunately being based on 17/23 tons for two/three-pier bridge. This bridge was designed to a bare minimum factor of safety in order that it should be no heavier than the old heavy bridge, and it was not easy to increase its capacity. A further 2 tons were obtained by the addition of a limited articulation device, and the bridge had to be stretched to the absolute limit to take 26 tons. This equipment was therefore overloaded from the start ; it also had a number of troubles in connexion with trestles, the feet of which were always sinking under these heavy loads, but it was nevertheless the only floating bridge we had at the beginning of the war. The trestle problem was acute, and a number of accidents began to occur in training due to their collapsing under load. A long landing bay was produced to span the gap between the floating bridge and the shore, but it was of limited application, since it could only span a clear gap of some 30 ft. and this imposed close limits on bankseat height.

Somewhat fortunately there had been a threat of a 30-ton tank in about 1936 and the Large Box Girder (L.B.G.) Mark 2 had been produced to cope with it. This had a clear span of 130 ft. but the erection of a four-girder bridge was a slow operation. The Hamilton Unit Construction Bridge designed by Mr. A. M. Hamilton, an engineer in P.W.D., Iraq, was also produced about 1937 and would take the same load over 120 ft., but although very easy to manufacture it was even slower to assemble and launch than the L.B.G., the erection of a 120 ft. bridge being regarded as a week's work. The Hamilton bridge, however, is notable for one feature, in that it is possible to erect the girders as single or double truss according to the strength required, the trusses being placed side by side. This feature will be referred to later. It was also possible to vary the strength of individual members by altering the number of angles from which they were built up. The 30-ton tanks did not eventually materialize owing to their high cost.

In 1938 the newly formed Mobile Division (which became 1st Armoured) stated a requirement for a floating bridge to take all their transport except tanks, which meant a capacity of 9 tons. Lightness and speed of erection were to be paramount, and difficulty of manufacture could be accepted in view of the small numbers which were required. By the use of the principle of " limited articulation " and the provision of a new superstructure on the existing folding boats, the capacity of F.B.E. was raised from 5 to 9 tons with no increase in overall

weight. Speed of erection was such that the unit which came to do the trials built 120 ft. of bridge across the river at Christchurch in forty minutes in the dark, having only seen the equipment for the first time that afternoon. This equipment became so popular that it was adopted for use throughout the army in 1939 and has served as the " Class 9 " floating bridge throughout the war. The only department which regretted this decision was the one which had to get it manufactured; since full advantage had been taken of the concession in the original specification that difficulty in this respect could be accepted.

The adoption of the " Class " system for marking of bridges and vehicles took place in 1939, after some opposition on the score that " vehicles already carried too many numbers." Prior to its introduction the only method of telling whether a vehicle could safely cross a bridge was to stop it, determine its type and number, look it up in a table, and see whether it was classed as light, medium or heavy. An added difficulty was that the table was always a year out-of-date, and never seemed to cover more than a fraction of the existing types of vehicles. The class system has been of outstanding value to " Q " staffs who classify and mark routes by it. Its easily visible numbers also ensure that overloads or, at any rate, too great overloads do not attempt to cross bridges, and it further assists in keeping those permanent competitors, the tank and bridge designers, on reasonable terms with each other.

The advent of the Matilda necessitated re-design of the S.B.G. to raise its capacity from 19 to 26 tons. This had been done some time earlier during an idle period but no bridge had ever been produced. The designers were therefore in the happy position of being able to reply to the demand by sending the drawings by return, and the bridge was in production within a very few weeks. It replaced the S.B.G., Mark 2, in 1939.

About this time Professor C. E. Inglis of Cambridge University produced a modernized version of his famous tubular bridge of the last war by incorporating the truss system which has already been referred to in connexion with the Hamilton bridge. This gave a girder of variable strength which could be used for a variety of purposes and was so versatile that it was adopted as the divisional bridge in replacement of the S.B.G., as well as being used for L. of C. bridges. It was originally designed for Class 24 but its capacity was increased later.

A certain amount of bridging equipment was sent to France in 1939/40, but was unhappily never used, and was all destroyed or captured. It was, however, practically all that existed at that time. After Dunkirk it became obvious that still heavier tanks would be required for the eventual counter-offensive against Germany, and in 1940 the Churchill was being developed at 45 tons. Methods were devised for strengthening the Inglis bridge but a number of extra parts were required and their addition detracted from the original simplicity of the design. No floating bridge for this load existed at all.

Early in 1941, Mr. D. C. Bailey, who had by this time risen to the post of Chief Designer of the E.B.E. (now nearly 400 strong), produced his idea which subsequently became the famous Bailey Bridge. The evolution of this bridge has been described in some detail in an earlier issue of the *R.E. Journal* (December, 1944) and will not be repeated here. Its very great advantages were that it was easy to handle and launch, it would cater for a variety of spans and loads, including loads up to 70 tons, it could be made into a heavy floating bridge without the use of trestles, and it lent itself to mass production.

As will appear from this account so far, the army had by now accumulated a variety of different types of bridge, all with their attendant difficulties of manufacture and training. It soon became obvious, however, that the Bailey bridge would take the place of nearly all of them. It could be used as a heavy

or light bridge, fixed or floating, and was as quick to erect as any and considerably quicker than some. Further, it provided a bridge which would take care of any reasonable future flights of fancy on the part of the tank designers, as well as being able to carry tanks on transporters, which was a new problem that had arisen. Production was therefore stopped on Pontoon Bridge Mark 5, S.B.G., L.B.G., Hamilton and Inglis, and was concentrated on Bailey. This production finally occupied 650 firms, who between them made over 200 miles of fixed and 40 miles of floating bridge for the combined use of the Allied Armies in Europe. Further production also took place in U.S.A. for the Far East.

A further point regarding the Bailey Bridge, upon which censorship has recently been relaxed, is the fact that it can be used for a number of special purposes. The most important of these is its use as a continuous bridge over a number of piers to replace a demolished viaduct. (See Plate I.) The piers themselves can be built up to the necessary height in the form of towers made of Bailey equipment. This feature has proved of enormous value, particularly in Italy. Other uses are as a canal lock bridge—on the rise and fall principle between two Bailey towers—and as a 400 ft. suspension bridge. (See Plate 2.) The latter is a most impressive structure and apart from the cables and suspenders, requires very few special parts additional to the standard equipment. Useful rafts can also be made from special assemblies of the floating bridge.

Now that tanks had reached weights of over 40 tons, it was accepted that building a bridge to carry them was a major operation, and that a considerable bridgehead would be required before such a bridge could be erected. It was therefore necessary to build up and maintain this bridgehead by means of rafts. The smallest type was built on assault boats to carry jeeps and anti-tank guns, since these are required in the early stages to deal with armoured counter-attacks. Class 5 and Class 9 rafts, based on folding boats and pontoons respectively, were next produced, in order to cater for close support vehicles, and the tanks themselves were carried on the 50/60 raft which was a special equipment designed for this purpose only. To propel these rafts shallow draft motorboats were provided, as well as a range of outboard motors varying from 4 to 50 h.p., the majority of which are of American design.

The Germans were the first to produce a fast "stormboat," and the Americans later produced an excellent boat on the same lines driven by the 50 h.p. outboard motor. This boat was designed to be driven ashore on any reasonable bank at full speed, and used to travel 20 to 30 yards on land before coming to rest, the motor tipping up to protect the propeller. The standing joke at Fort Belvoir, Virginia, was to invite unsuspecting senior officers to go for a trip in this boat, finishing by putting them ashore at 25 knots. This procedure was not uncomfortable, but never failed to produce maximum and visible consternation to the uninitiated, who invariably thought that their helmsman had suddenly gone mad. This boat was unfortunately too small to meet British G.S. requirements, since the latter included carriage of jeeps or anti-tank guns, and a larger stormboat was therefore produced in England powered by the same 50 h.p. motor. This, although slower, has been very successful, but until somebody invents an outboard motor which can be guaranteed to start under all conditions, the problem of propulsion will not be satisfactorily solved.

Since 1939 there had been a G.S. requirement for a self-launching bridge, but the technical difficulties in devising one were so great that it was over three years before a design of any practical value was produced. Every conceivable launching system was investigated—mechanical, hydraulic, cable-operated, or various combinations of these methods. The first Scissors

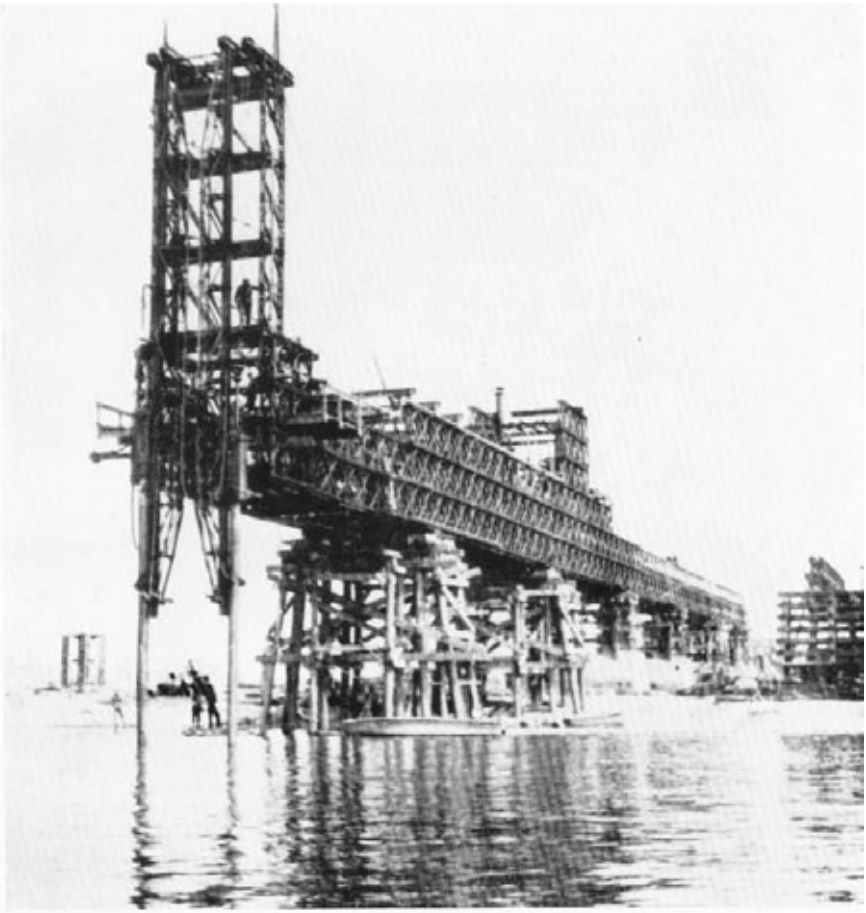


Plate 1.—Semi-permanent Bailey Bridge on timber piles under construction at Xanten (River Rhine). Photo shows piles being driven at head of cantilever, prior to rolling entire superstructure forward.

20 years in the development of military bridging 1925-1945

Plate 2.—A 400 ft. Bailey Suspension Bridge.

Plate 3.—30 ft. Scissors Bridge, carried on Covenanter Bridgelayer, being launched.

20 years in the development of military bridging 2 & 3

bridge was evolved from a model made by an R.E. officer at his home, from a cardboard shoe box, but a number of variations had to be incorporated before it became a practicable proposition. A prototype on this principle was made and fitted to a Light Tank Mark 6, which carried and launched a folding bridge 30 ft. long and this worked reasonably well. It was shipped to the Middle East in response to an urgent operational demand, but no word, either written or verbal, has been received to this day as to whether it was ever used, or even that it ever arrived at all. The designers hoped optimistically that it had been instrumental in breaching the defences at Bardia, which occurred shortly after its estimated time of arrival

G.S. requirements had by now risen to a Class 24 bridge, and the present Scissors, carried first on a Covenanter and finally on a Valentine chassis, was the result. (See Plate 3.) It has been used a number of times in operations, but has had a mixed Press, some units saying that they could not have done without it and others that it is a complicated gadget. It is unfortunately difficult to design a bridge which can be carried in a reasonable position for transport, and which can be power-launched without exposing the crew, to which this term is not applicable.

The Churchill bridgelayer was an attempt to simplify the design and to raise the capacity of the bridge, but even in this certain complications are inevitable. This again has its supporters and its critics. The main criticism of both types of bridge is the limited gaps which they will span, but as long as the layer has to be built on any of the present service tank chassis, mechanical difficulties preclude any great increase in length.

The first part of our offensive campaign in N. Africa involved few bridging problems, but the advance through Italy with its mountain gorges and swift flowing rivers involved bridging on a scale which had never been met before. Never in history has an army carried out demolitions to the degree practised by the Germans in their three years of retreat, and never before has a fully mechanized army had to advance for such a distance in pursuit. It has been necessary to erect over 3,000 Bailey bridges in Italy and at least half as many in North West Europe, culminating in the crossing of the Rhine, over which the first Class 40 bridge was built in thirty hours. The longest Bailey so far erected is just over 5,000 ft; this is a semi-permanent bridge across the Rhine supported on piles.

Certain changes in the carriage of bridging equipment in the field have also taken place during the war. The divisional bridges were originally F.B.E. and S.B.G., one set of each being carried in the Field Park Company. As has been stated earlier, a 60 ft. Inglis bridge replaced the S.B.G. in 1939, but very shortly afterwards an 80 ft. Bailey bridge took the place of both Inglis and F.B.E. The purpose of this was to bridge the unforeseen obstacle, and it was recognized that platoons from the Bridge Company would be attached as required when bridging operations were imminent.

The reorganization of the Bridge Company, R.A.S.C., on to the "brick" system took place in 1942, and greatly simplified control and planning of bridging operations. By this system the Company can consist of a variable number of bridge platoons (Bailey, Pontoon, F.B.E., Raft, etc.) to suit the projected operation, and as has been mentioned above, these platoons may be sent forward and attached as required to Field Park Companies. We have, in fact, very nearly achieved the ideal of carrying a standard bridge in a standard manner whilst retaining 100% flexibility.

The final word should be said about the Sappers themselves. Their major role is to assist the army to advance. The skill and determination with which they have carried out that role in this war, both in mine-clearing and in bridging, can seldom have been surpassed.

A RAILWAY BRIDGE ACROSS THE RHINE

By Brigadier R. F. O'D. Gage, C.B.E., M.C.

(Republished from the *R.U.S.I. Journal* for November, 1945, in which the title was "A British Bridge across the Rhine.")

Introductory

BETWEEN D-Day and VE-Day the Railway Construction Branch of the Transportation Service, Royal Engineers, completed the repair or construction of 122 railway bridges, of a total length of four miles, on the British railway lines of communication in N.W. Europe. Almost the last bridge to be completed and probably the most spectacular was across the River Rhine at Spyck.

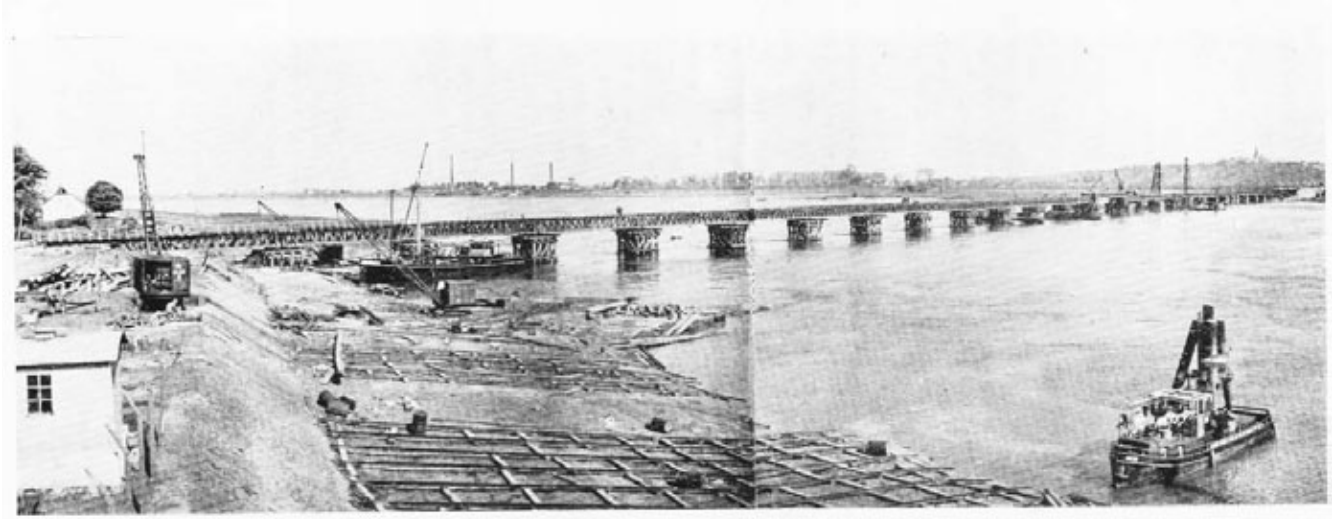
Long before D-Day it had been realized that the construction or repair of railway bridges across the Rhine was a probable commitment for the dim and distant future. By the end of 1944 the prospect was no longer so dim, and by early in 1945 the Transportation Service received definite instructions to be prepared to effect a rail crossing of the Rhine somewhere in the Emmerich area. The selection of this area, which was determined by the military operational plans and by inter-Allied boundaries, committed the Tn. Service to the construction of a new bridge at some point where there never before had been a bridge, and to the development of railway connections with the existing railway systems east and west of the Rhine.

Intensive examination of air photographs and intelligence data revealed that the water gap throughout the area was some 600/700 yards wide, 20/25 ft. deep at normal level, with a current of three knots rising to a maximum of five knots. From the purely bridging point of view it appeared that one site was as good, or as bad, as another and the ultimate selection of a site would therefore be influenced largely by the work involved in constructing the approaches.

At Spyck on the west bank of the river some three miles downstream of Emmerich, there is a chemical factory connected by standard gauge railway to Cleve station, 3 miles distant. Spyck, therefore, appeared to be the obvious choice, especially as the existing railway east of the Rhine is only 1½ miles away from the river at that point. By selecting Spyck, not only would the need to construct a new railway to the west bank of the river be eliminated, but, even more important, it would be possible to transport heavy materials and plant direct to the bridge site by rail. A decision was, therefore, taken to cross the Rhine at Spyck, subject to confirmation by reconnaissance that the site was suitable.

Preliminary Work

Although a preliminary estimate of 2½ months had been given as the probable time to effect a crossing, it was evident that speed would be the essence of the contract and the rapid establishment of rail communications across the Rhine might well be an essential factor in bringing the campaign to an early conclusion. Accordingly, very great attention was given to ensuring that all the stores, plant, equipment and personnel needed for the project would be available when wanted. A preliminary design was prepared and steps were taken to ensure that everything likely to be required was actually available in Stores Depots, where it was "frozen," whilst stores and plant likely to be needed early were moved to a forward dump, some being held on rail under load. The necessary personnel, amounting to some 1,300 in all, were selected from units with wide experience of pile driving and girder erection, and included a Port Construction and Repair Group and I.W.T.



View from near bank upstream side, showing completed bridge. Note 105 ft. four girder, through type, U.C.R.B. span over navigational opening. The rails in the foreground, on the south bank, are a slipway which was constructed to launch the N.L. pontoons for building rafts to carry the floating piling frames. It was also used to skid piles into the river, where they were taken in tow and floated to the various piling frames.

A railway bridge across the Rhine

Railway bridge over the Rhine at Spyck.
Spans in position and ready for launching.

A railway bridge across the Rhine 1

Units to provide expert assistance in watermanship and for the handling of the various tugs, ferrycraft, etc. The craft themselves were concentrated at Nijmegen in Holland ready to move up the Rhine when it was clear of enemy.

It was felt that, provided the spans were erected and launched from both banks, the rate of pile driving rather than girder erection would be the limiting factor, and a fleet of 20 dukws was therefore obtained to ferry steelwork and other materials across the river, in the absence of a road bridge in the neighbourhood.

That all this planning behind the scenes was to pay a handsome dividend was clearly demonstrated later, for at no stage was work held up or delayed by lack of stores.

The Allied assault across the Rhine commenced on 24th March, but it was not until 4th April that the bridgehead had been expanded to include the Spyck area. Reconnaissance was started immediately and by the following evening, 5th April, a final decision was given to use the Spyck site. Work was commenced on 7th April.

Reconnaissance had revealed that the approach line to Spyck was only just above flood level and consequently it would not be practicable to construct the bridge at an elevation sufficient to permit of navigation by Rhine steamers under flood conditions. It was, therefore, decided to incorporate in the design one navigational span of 105 ft. in mid-stream, which could be converted to a lifting span later. In addition to the construction of a bridge over the main river the work of providing a complete rail link involved the clearance of wreckage and the construction of traffic loops in the badly damaged station of Cleve, heavy maintenance and repairs on the 3 mile approach line to Spyck, repairs to the 342 ft. span bridge at Griethausen which was damaged by shellfire, and the strengthening or strutting of a flood gap consisting of twenty spans of 66 ft. between Griethausen and Spyck. On the east bank 1½ miles of new railway would have to be constructed, the earthwork for which was estimated at 50,000 cu. yds.

Construction

As finally designed and constructed, the bridge comprises 27 spans of 75 ft. two-girder deck type Unit Construction Railway Bridge, one span of 105 ft. four-girder through type Unit Construction Railway Bridge, and six spans of 35 ft. R.S.J.s. The girders are supported on 27 timber piled piers, 6 steel trestle piers and two timber raft abutments.

Immediately the decision had been taken to use the Spyck site orders were issued to put the work in hand as already planned. The factory yard was laid out as a stores dump and a site was selected for the preparation of piles and other timberwork; two floating pile drivers which had previously been rigged at Nijmegen were towed upstream to Spyck, together with a fleet of landing craft, sea mules, Dutch tugs and powered barges; and stores and plant commenced to flow to the site in a steady stream by rail and road. Meanwhile surveyors were at work on taking sections and measurements, and draughtsmen were preparing site drawings.

The correct measurement of the gap and setting out of work were of primary importance, for it would, to say the least of it, have been awkward if the two halves of the bridge had failed to meet accurately in the middle. Responsibility for this work, and for checking alignment and distance during construction, was entrusted to a detachment of a Railway Survey Company.

The simple method of direct measurement could not be used owing to the width of the water gap. Accordingly base lines were laid out on

each bank of sufficient length to give good intersecting rays, and the two points were located where the bridge line intersected the base lines. From these points the gap was measured, the difference in independent measurements from the two banks being 0.19 ft. This all sounds simple enough, but there were in practice many difficulties. For example, the east bank was heavily mined and no time could be spared to clear the minefield; the surveyors had to prod for, and remove, the mines on the lines along which measurements had to be taken. Several centre line pegs were fixed on each bank, from which the bridge line could be produced as construction progressed.

Construction commenced with the preparation of bank seats, erection of steel trestles for the approach spans, and pile driving in the land piers, using 19 R.B. Crawler Cranes fitted with false leads and a piling monkey. Concurrently work proceeded on the assembly of a further four floating pile drivers mounted on N.L.* pontoon rafts, which were made up on the site and launched from a slipway.

Pile driving in the river was started on 16th April, the piling rigs working out from each bank towards midstream. As the driving was completed in each pier, capping and bracing parties took charge and completed the pier, using 19 R.B. Cranes and air compressors mounted on N.L. pontoon rafts, and derricks rigged on Dutch barges. Finally, temporary steel gantries were fixed in position ready to receive the girders and lower them into position. All the materials for this work were ferried, or towed, out in dukws, which also transported all the girder parts required for erection on the far bank.

In locating the pile piers the two corner piles on the upstream face of each pier were accurately fixed; for each of these piles the deflection angles from the base line stations were calculated, each set of calculations taking about threequarters of an hour. After some experience and refinements in the method of signalling it was found possible to position a pile driving raft in about fifteen minutes.

Signalling at night presented a problem. At first, telephones were laid from survey stations to the piling rafts, but cables were continually broken and telephones were abandoned in favour of coloured lamps; this method proved very successful on the system of red for "upstream," green for "downstream" and white for "in position."

Erection of the U.C.R.B.† spans proceeded concurrently on both banks. The 75 ft. spans were bolted together in threes to provide a counterweight for launching—thus obviating the need for a launching nose—and were pushed forward by a 350 h.p. Diesel locomotive on the west bank and a bulldozer on the east bank. As each pier was completed a span was pushed forward, unbolted from its counterweight spans, and lowered on to its bearings by chain blocks attached to the temporary steel gantries. The rail track was then laid, in readiness for the next launch.

At last there remained only the 105 ft. navigational gap. The U.C.R.B. for this was taken out with the four girders erected as a deck span; after launching and lowering the girders were spread, cross girders and stringers were lifted into position, track was laid and all was ready for the test train. The job had taken one month.

During the construction of the bridge work had proceeded on the approaches. Fifty-nine pieces of mechanical equipment were used to move 55,000 cu. yds. of earthwork on the east bank approach lines; the main span of the Griethausen bridge had been repaired and tested and the twenty flood spans strutted with steel trestling; debris had been cleared from Cleve

* N.L. Pontoon: American Naval Landing Pontoon.
† U.C.R.B.: Unit Construction Railway Bridge.

Station and six running loops and a reversing triangle had been constructed. The work proceeded smoothly from start to finish, working first in two 12-hour shifts and later in three 8-hour shifts. Illumination for night-work was provided from standard 4½ kw. generating sets and a battery of diffused A.A. searchlights.

The only delays experienced were caused by the weather. On two occasions high winds blowing upstream produced waves of such magnitude that the pitching of piles and pile driving were impossible, and on the last day a wind of gale force caused some anxiety while the 105 ft. span was being launched; at one time the girder was deflected over a foot by the wind pressure.

Statistics generally make dull reading, but the following indicate the scope and complexity of the problem. A brief indication of the work involved as disclosed by these figures shows that the completion of the task in one month was a creditable accomplishment.

Bridging.

Length of new bridging—Wet gap ..	1,900 ft.
„ „ „ „ Dry gap ..	440 ft.
Repairs to Griethausen Bridge	342 ft.
Strengthening approach spans 20 × 66 ft.	1,320 ft.
Total length of bridging involved ..	4,002 ft.

Piling.

Wet Gap :—	Dry Gap :—
20 piers of 16 piles each	2 piers of 16 piles each
2 „ „ 24 „ „	1 pier „ 9 „
2 „ „ 34 „ „	

Total .. 477 piles (average length 60 ft.; average penetration 20 ft.)

Steelwork erected and fixed		1,200 tons
New railway track laid		2,750 yds.
Earthwork		55,000 cu. yds.
Number of men employed :		
Royal Engineers ..	760	
Pioneer Corps	597	
R.A.S.C.	29	
Total ..	1,386	

Total Man Hours 344,442 (excluding supply and delivery of materials, but including approaches and ancillary works).

Conclusion

The announcement of VE-Day on the very day on which the bridge was completed came as something of an anti-climax and was received with mixed feelings by the men on the job. To some extent they had been cheated of their rewards for the bridge could not now be used for its primary purpose—the support of military operations against Germany. The fact remains, however, that it was a fine engineering achievement and it has proved of inestimable value for post-hostilities traffic. A flow of 21 military stores and personnel trains each way passes over it daily and tens of thousands of B.L.A. leave personnel have gone across it on their long journey to and from the Channel ports. At each end of the bridge stands a notice board which reads "Victory Bridge."

REFRIGERATION OF FOOD IN THE ARMY

By Lieut.-Col. B. Trott, O.B.E., R.E.

THE Army's needs for refrigeration, whilst following normal civilian requirements, are much more exacting, the conditions under which plant and cold stores have to operate varying much more widely than their civilian counterparts.

Cold stores, ranging from 2,000 tons capacity down to 6 tons capacity, have been introduced, the larger sizes above 50 tons being for static locations, bases and L. of C. points, a 50-ton store is semi-portable, and 10-ton and 6-ton stores are designed for use in forward areas of the Army in the Field.

To cater for those conditions where transport from the base to the forward areas are long and subject to delay either by rail, river or coastal vessels, a mobile refrigerating plant has been introduced.

The Army has not been consistent in the method of refrigeration employed, but this has been due primarily to the urgent need of the equipment and for accepting such plant as was available. Whilst generally the larger sizes of cold stores are refrigerated with an ammonia-brine system, both this and the direct expansion system are in use.

As regards refrigerants, Freon 12 which is odourless, non-toxic, non-inflammable and innocuous, is undoubtedly the most desirable in the majority of cases, but owing to the virtual monopoly of the U.S. in this refrigerant and consequent short supply in this country, ammonia has been accepted for the larger sizes, leaving Freon 12 for use in the smaller 10 and 6-ton sizes. Even in these latter sizes scarcity of Freon 12 has necessitated the same use of Methyl-Chloride, in spite of its many disadvantages and the need to replace any aluminium parts in the compressor or gas circuit.

Construction of the Cold Stores

Simple construction has been aimed at in all cases.

In the case of the static base stores of 100 tons capacity upwards these have been designed to have brick walls with an air cavity, 9 in. cork insulation with final cement finish, the roofs being of reinforced concrete with 10 in. of cork insulation and cement finish, the floors being of hardcore, sand filling and 7 in. cork insulation, finishing with a final concrete floor, having, where possible, a granolithic finish.

It will be seen, therefore, that cold losses have been well catered for but at the same time no frills have been introduced.

With the 50-ton store, which is semi-portable, construction is by pre-fabricated panels having 8 in. slab cork insulation in a timber framing, the two flat surfaces being clad with galvanised iron sheet. Joints between external panels are made by sponge rubber gaskets, the panels being tightened up on the gaskets by tensioning bolts threaded through the panels.

The 10-ton cold store was designed to be entirely portable, capable of being erected and dismantled at comparatively short notice. This also was of panel construction using cork insulation. It is at present under redesign, with the probable application of one of the light-weight plastics as an insulation media.

In the original design the packing case for the cold store formed also its

housing in the field, affording protection from the sun and rain. To render this strong enough to resist damage occasioned by transport, erection, dismantling and re-erection would mean increasing the thickness of the timber construction of the case to such a degree as to destroy largely its transportability. Later design will have a normal packing case, light tubes being provided to enable a tubular structure to be erected over the cold stores and covered with tarpaulins.

Plant

All the plant provided for the operation of the static cold stores have been diesel engine-driven, two stage, ammonia compressors—incorporating ammonia liquid intercoolers, and the usual equipment of precoolers, condensers, receivers, evaporators, etc., and where necessary brine equipment. Plants have been duplicated, each set being capable of operating the store at normal duty loads with internal temperatures of from 13°F. to 18°F. when the external ambient temperature is at 113°F. and with maximum humidity conditions.

The 50-ton cold store will normally operate with the plant unit provided for the mobile refrigerating equipment, though it may operate as a static unit either with the mobile refrigerating unit or from any suitable brine circuit.

The 10-ton and 6-ton stores have been provided with single plant units only, the engines being either petrol or diesel type. In the new design of these stores, the store and the plant will form entirely separate units, the plant may be either motor or engine driven connected up to the cold store, each type of plant being interchangeable.

As stated previously the refrigerant for these plants may be either Freon 12 or Methyl-Chloride, but it is hoped that as the Freon 12 situation improves this will be used exclusively.

On the whole, little complaint has been received from users of the stores; complaints, where any have been made, have been on the inadequacy of the plant of the early 10-ton stores and its somewhat poor construction. These stores were, however, designed originally to take frozen or chilled meat; they have been used to chill freshly killed meat hence, the apparent inadequacy of the refrigerating unit.

Mobile Refrigerating Equipment

Early in 1944 the question of the supply of fresh meat to troops operating in the tropics, well in advance of base stores and often days in advance of rail-head, became a pressing one, the wastage in maintaining adequate supplies with delivery on the hoof, under adverse climatic conditions, having grown to large proportions.

The problem was to preserve frozen or chilled meat from the base during a rail journey of anything up to eight days to rail-head and truck journey two to four days beyond rail-head, the question of transport by river or coast barge having also to be considered.

Investigation was made as to the methods adopted in other countries, these, however, made use of dry ice or eutectic tanks and, owing to the lack of suitable dry ice plants in the theatre of operations and the undesirability of setting up a large number of cooling stations along the route if eutectic tanks were used, it was decided to devise a portable refrigerating plant, which would be suitable for rail or barge transport, and to construct suitable containers fitted with refrigerating grids for rail or road transport. In the case of the barges or coastal craft the installation of suitable cork insulation and grids for cooling presented little difficulty.

It was decided that the method of operation would have be to a mobile

refrigerating unit which could be mounted on a rail truck and connected to a number of refrigerated containers, the container being of such a size and weight as could be carried by the standard Army 3-ton truck. On reaching the rail-head the containers would be disconnected and transferred to the truck, the insulant value of the containers, together with the eutectic value of the solution in the grids fixed in the containers, to be designed to keep the meat in a sound condition for at least four days.

The same mobile refrigerating unit to be used for the barges—one for the forward hold of about 4,500 cubic feet, one for the after hold of similar capacity and one also for cooling the 50-ton (approximately 4,500 cubic feet) semi-portable cold store.

Considerable thought was given to the most suitable refrigerant to be used. Risks of fracture to the piping during rail haulage, and the practical impossibility of avoiding wastage at the connections between containers when these were disconnected, coupled to the fact that ammonia was in free supply in the country adjacent to the theatre of operations, resulted in an ammonia-cum-brine system being adopted, the brine being circulated through the grids in the containers or the barges or the cold store.

Plant

The plant unit consists of a diesel engine, with hand controlled clutch, driving a two stage ammonia compressor, with the normal complement of condenser, evaporator, brine pump and brine mixing tank. Drives for the various units are by Vee belts, and the engine is arranged for electric starting. The plant has a capacity of 45,000 B.T.U.'s per hour.

The whole is assembled in a mild steel housing 13 ft. 1 in. in length, 6 ft. 6 in. in breadth, height at sides 6 ft. 6 in. to maximum height at centre of 7 ft. With this size the unit is capable of operating on the loading gauge of any railway likely to be met in any area. Its total weight is approximately 7½ tons.

Containers

These consist of a light aluminium alloy box, rigidly constructed and insulated with cork between the inner and outer shells, the inner shell being of the same but lighter gauge alloy as the outer shell.

Ceiling grids are fitted and the connecting brine main passes through the wall of the container from each grid into valve cupboards situated at the four top corners.

A dial thermometer is built into the container and indicates the temperature of the air space inside the container.

Each container is provided with its own lifting shackles and weighs approximately 30 cwt. when empty. It is capable of holding about 1 ton 15 cwt. of carcase meat or 2 tons of boned meat.

Its overall size is 7 ft. 9 in. by 6 ft. 9 in. by 7 ft. 3 in. high, with a standard insulated door 3 ft. by 5 ft. 3 in. high, the internal capacity being 170 cubic feet.

Barges

The cooling equipment of each hold consists of brine grids mounted on the ceiling and walls and the insulation is of cork. The arrangement is such that temperatures of 15°F. to 18°F. can be maintained, when the external ambient temperature is at 113°F., by using one of the refrigerating units of 45,000 B.T.U. per hour for each hold.

MEMOIRS

MAJOR-GENERAL F. C. HEATH-CALDWELL, C.B.

FREDERICK CROFTON HEATH was the second son of Admiral Sir Leopold Heath, K.C.B., R.N., and the elder brother of Maj.-Gen. Sir Gerard M. Heath, K.C.M.G., C.B., D.S.O., who was Engineer-in-Chief in France in 1918. He was born in February, 1858.

He was educated at Brighton College, but left for Wimbledon school to prepare for the R.M. Academy, which he entered 21st on the list, coming out in the 2nd place for the Royal Engineers in 1877. At school and at Woolwich, he played half back for the football team and also won prizes for hurdles and the high jump.

In 1880 he went out to Malta with the 17th Company R.E. for garrison duty, but in 1882 this company and two battalions of infantry from the garrison were embarked for Egypt, at a few hours' notice, in H.M.S. "Agincourt" and H.M.S. "Northumberland." The bombardment of Alexandria followed in a few days and two days later, the 17th Company, commanded by Captain Elliott Wood, R.E., landed at Alexandria; Heath was the senior subaltern. Alexandria was occupied by a force of 15,000 men under Sir Archibald Allison, and this was followed by the larger force, under Sir Garnet Wolseley, which landed at Ismailia, fought the battle of Tel-el-Kehir and occupied Cairo. The 17th Company joined this force and was equipped as a Field Company with the Army Headquarters and took a prominent part in the advance. The company was retained in Egypt until 1884 when it was moved to Suakin to prepare for an expeditionary force, under the command of Sir Gerald Graham, which arrived three months later. There was a mass of R.E. work in connexion with water supply, roads and defences, and the company constructed a causeway to Quarantine Island, the principal store depot. At the end of the campaign Heath was mentioned in despatches and noted for promotion to Major when he reached the rank of Captain, a brevet which he received in January, 1888.

During 1886, he accompanied one of the sons of Lord Salisbury to Germany, and while there worked for the Staff College, which he entered at the end of 1886, after a few months at Aldershot.

From 1889 he commanded B. Troop of the Bridging Battalion at Aldershot, and in 1891 was ordered to Egypt as O.C.R.E., Alexandria, until, in the spring of 1894, he was appointed Brigade Major, S.M.E., where he remained for five years.

In 1899 he was selected as one of a group of secret service officers who were sent to South Africa, a few months before the outbreak of war. He was employed in reconnoitring the S.E. corner of the Free State. When the war started he became a Staff officer to the G.O.C., Lines of Communications, preparing base camps, stores and depots. During 1900 he was the Chief Staff Officer, graded as A.A.G., to three flying columns in succession in the Orange River and North-Western Provinces: in August he was O.C. Troops Hoopstadt. In April, 1901 he was A.A.G. to the G.O.C., Midland District, Cape Colony and ended the war in command of a flying column in the Orange River Colony. For his services he was mentioned in despatches and given the Brevet of Lieut.-Colonel.

Soon after the end of the war he was sent to Gibraltar as C.R.E. South, coming home to be C.R.E. London in 1904. In 1906 he was promoted substantive Colonel, on appointment as A.A.G.R.E. at the War Office, where he was one of the three officers—the others being the D.F.W. and the

Inspector, R.E.—who had to control the Corps under the new organization of the Esher Committee. In October, 1908, he was made Inspector of R.E., with the rank of Brigadier-General, and received the C.B. in 1910.

In 1913 he was given the command of the Scottish Coast Defences, which he held when the war started in August, 1914. He had been promoted to Maj.-General in July, 1914, and in September, 1914, he was appointed Director of Military Training at the War Office.

When Lord French was brought home, as G.O.C., Home Forces, at the end of 1915, he took over all Military Training, and Heath was for a short time unemployed, until given the command of the Portsmouth Garrison, which he held till 1918. Then he was lent to the newly formed Air Force to command the S.E. area of the R.A.F. This completed his military service and he retired in February, 1919.

In March, 1913, he succeeded to a property known as Linley Wood, Talk-o'-th'-Hill, Staffs, under the will of his great-uncle, James Stamford Caldwell, and took the name of Caldwell. He was married in January, 1889, to Constance Mary, only child of Lieut.-Colonel Helsham Jones, R.E., who survives him. They had two sons, the elder joined the Royal Navy and was a Lieut.-Commander during the war of 1914–1918. On retirement he took Holy Orders and is now Captain The Rev. C. H. Heath-Caldwell, D.S.C., late R.N.; the younger, a 2nd-Lieut. in the R.H.A., was killed in action in May, 1915, near Bethune.

Heath-Caldwell was well known in the Corps as a gifted and reliable officer, who was early marked for employment in one of the leading positions in the Corps. He was a good French scholar and his experience on the Staff in South Africa qualified him for a senior appointment in the Expeditionary Force of 1914. It was bad luck for him, and perhaps for the army, that the outbreak of the war found him in an appointment with Coast Defences. While he was Inspector of Royal Engineers he had held the dormant appointment of Engineer Adviser to the C.-in-C. of the Expeditionary Force, which developed later into Engineer-in-Chief, and the decision, that the commands in the Kitchener armies should be given mainly to officers who had served with the Expeditionary Force in 1914–1915, adversely affected his further chances.

In addition to his athletic activities already referred to, he was interested in many forms of sport. At the Staff College he was Honorary Secretary of the College Drag Hunt, and at Alexandria he was Honorary Secretary of the Khedivial Sporting Club, which he took over in a bankrupt condition and left two years later with a credit balance of about £700, having at the same time established the Golf Club and improved all the other facilities for games.

After his retirement in 1919 he settled down to the life of a country gentleman, his amusements, in addition to the care of his garden, were tennis, shooting and hunting, the last he shared with his wife, and in addition he gave liberal help and support to many local religious, social and philanthropic institutions, was President of the local branch of the British Legion and devoted much of his time to his duties as J.P. for the County of Cheshire.

He passed away in September, 1945. W.B.B.

Major General Frederick C Heath-Caldwell CB

Lt-Col Richard Ward OBE MC RE

LIEUT.-COL. RICHARD STEPHEN BARRINGTON WARD, O.B.E., M.C., R.E.

R. S. B. WARD was born in Berlin on the 16th February, 1909. He was educated at the Oratory School at Caversham and passed into Woolwich in 1928. He was commissioned in January, 1929, and after doing the normal course at Chatham and Cambridge he proceeded to India in 1932 and was posted to the Bengal Sappers and Miners at Roorkee. Later in the same year he was posted to the M.W.S. in India. He returned home in 1937 and was appointed Adjutant of the 47th A.A. Bn. T.A.

At the commencement of the war in 1939 he was at first employed in connexion with chemical warfare. Early in 1941 he was posted to the Burma Sappers and Miners at Maymyo. In February, 1942, he was appointed C.R.E. 17 Ind. Div. and in September, 1944, he was C.R.E. 39 Ind. (Trg.) Div. In April, 1945, he was about to take up another appointment when he was posted to fill an unexpected vacancy as C.R.E. 26 Ind. Div. just before the attack on Rangoon. He was killed a few weeks later during the actual attack, when his landing craft struck a mine.

To many sappers in S.E. Asia the loss of Dickie Ward in the landings at Rangoon was a blow which quite marred the success of the operation. For he was one of the outstanding characters of the S.E.A. theatre of war.

I first met him as the C.R.E. of the 17th Ind. Div., for which job he had been chosen by the Div. Comdr., over the heads of other senior men, in March, 1942. He had already won an immediate M.C. for gallantry at the Sittang River, and throughout the 1942 withdrawal his unfailing courage and cheerfulness, his extreme resource, and his marked readiness to accept any and every responsibility, were to distinguish him, despite his inches, as a big man in the fullest sense of the word. Throughout the next two years he added steadily to this reputation.

He was the perfect C.R.E. Absolutely in the confidence of the Div. Comdr., not afraid of saying what he thought to anyone, unfailing in support of his sappers as long as their views were reasonable, friendly with everyone, very energetic and ready to make an immediate decision at any time on any subject, extremely competent and wise in his decisions, very sound in his judgment.

He had a theory that men would not work well for anyone unless they liked him. He certainly lived up to this, for he was liked at sight by everyone, from the lowliest sapper to the Commander-in-Chief, and in two-and-a-half years I heard much in praise, but never a voice raised against him; surely a very remarkable record for a C.R.E.

He never interfered with his Company or Platoon Commanders as long as he felt that they knew what they were about, a restraint which must have cost him a great deal for he was never so happy as when mixed up in a battle, or scrap of some sort, where he had no earthly right to be. He went everywhere and saw everything, driving at a furious rate in a jeep, covered from head to foot in dust, and with his red face and red hair was affectionately known in the Division as "The Ball of Fire."

No finer or more competent officer ever existed, and the Corps is a sad loser by his death.

I.H.L.G.

COLONEL C. H. D. RYDER, C.B., C.I.E., D.S.O.

(Reproduced from *Empire Survey Review.*)

MY old friend, the late Colonel Ryder, was my immediate predecessor as Surveyor General of India, and I regard him as having been the greatest surveyor of his time. He well earned the Gold Medals of the Royal Geographical Society and the French and Scottish Geographical Societies, which, together with the D.S.O., were awarded to him in 1905, as described in the *R.G.S. Journal* for July, 1905. The October number of the same year gives his own lecture on his work in Tibet, and also Colonel Gore's comment on it as " a very modest account of what is, I think, the most wonderful bit of surveying that I can call to mind." Colonel Gore was at that time Surveyor General of India and himself a very able surveyor of wide experience.

Ryder was born in 1868 as the seventh son of Lieut.-Col. S. C. D. Ryder. His successes began with scholarships at Cheltenham College and taking a high place in Army exams. at the earliest possible age, so that he got his commission when only just eighteen. In 1891 he joined the Survey of India, which was then a carefully picked service. Here his qualities soon led to his selection for the difficult surveys with the Mekong Boundary Commission of 1894–5.

This apprenticeship to the art of surveying under great difficulties was a good preparation for his adventures in Western China in 1898–1900, which are described in his lecture published in the *R.G.S. Journal* for February, 1903. During these two field seasons Ryder, with a few Indian surveyors, was attached to an expedition in Yunnan under Major Davies, which was exploring the possibilities of railway connexions between Burma and China. Ryder's section was concerned with triangulation, astronomical fixings and general surveys, which first put the maps of Yunnan on a scientific basis over a very large area where previous information was scanty and inaccurate. The inhabitants were often difficult and occasionally hostile, Captain Watts-Jones, R.E., being killed while on a railway survey.

The entry each season was through the difficult country north-east of Burma. Exit after the first season was *via* Tonking, but in 1900 Ryder decided to cross China *via* the Yang-tse-Chiang, where he embarked on a raft at Yachao. When there was no going back he heard of the Boxer Rebellion from a missionary, who told him that, " the Legation in Peking was besieged and that there was a general massacre of Europeans throughout China." As he adds in his lecture : " This was cheerful news ; we were nine armed men [the Gurkha escort] and had 1,800 miles of river journey before we could reach Shanghai." He got through, however, and joined in the operations at Peking, for which he was mentioned in despatches.

His next adventure was in 1903–5 when he was chief Survey officer of the Tibet Expedition to Lhasa, assisted by those hardy triangulators, Captains H. McC. Cowie and H. Wood, both R.E., and a few picked Indian surveyors. Again he maintained a triangulation under most difficult conditions and made a good survey of all this new country, with large-scale maps of Lhasa and Gyangtse. This was followed by the perilous trek of 1,000 miles behind the Himalayas, when he and Captain Wood triangulated and surveyed right up the Tsang-po (or Brahmaputra) valley to the Mansarowar lake, and thence over high passes down the Sutlej to Simla. No one could foresee whether the Tibetans would prove hostile, and it was all " a race against winter," as they could not start before the middle of October, and they only just managed to cross the Aya La pass (18,700 feet) in December on the last possible day, arriving in Simla on 28th December.

Triangulation at these great heights so late in the season entailed severe hardship. They were accompanied by the political officers, Captain Rawling and Lieut. Bailey, with five Gurkhas and one Indian surveyor, Rai Sahib Ram Singh. I have indicated in my first paragraph how widely these achievements were appreciated by the world in general.

All these additions to our trans-frontier maps were made between 1894 and 1905, under conditions varying from the most fever-stricken tropical jungles to icy wastes at very high altitudes, with fantastic varieties of transport amongst races who might easily become hostile. We had other hardy officers who would have welcomed such opportunities, but I doubt if any one of them had all the necessary qualities in the same full measure. For, in addition to brains and physique, Ryder's mere presence inspired confidence. His kindly tolerance of other men's foibles and his patience with exasperating muddles were never ruffled, while his real goodness called out the best in all who met him. Though full of quiet humour he was a man of few words and very reticent about his own exploits, only showing his outstanding ability by the ease with which he got things done in the simplest possible way.

A great reorganization of the Survey of India was put through in 1906, and Ryder spent the next seven years in its most important post, as administrator of the six survey parties launched on the re-survey of the North-West Frontier from Baluchistan to Chitral. I was in charge of the largest of these parties and know how he won the confidence and respect of all ranks by the way he gradually perfected the new procedure. The work gave him an unrivalled knowledge of frontier and service problems, as well as the qualities of many of our best officers and surveyors.

In 1913, he and Cowie with some Muhammadan surveyors were attached to the Turco-Persian Boundary Commission to survey unmapped country along the 1,180-mile boundary from the Persian Gulf to Mt. Ararat. Much of the work lay in marshes or hot and waterless deserts, and the surveys of our party were soon accepted without question as far better than anything the Russians, Turks or Persians could produce. The outbreak of war in 1914 endangered the completion of the work, which was only broken up in October, 24 hours before Turkey entered the war. Ryder and Captain (afterwards Sir Arnold) Wilson had to rejoin by crossing Russia to Archangel, and thence round the North Cape to England and so back to India. Ryder was given the C.I.E. for this work, which is described in his lecture published in the *Geographical Journal* for September, 1925.

From 1915 to 1918 he held a key post in control of the Map Publication and other technical offices in Calcutta, which had to meet the strain of heavy abnormal demands due to the war. He was then Director of Survey Operations in Iraq for a year, where he effected notable improvements for which he was mentioned in despatches.

After this we were lucky to have him as Surveyor General of India from 1919 to 1924, to face the thankless task of getting things into shape after the war, in face of drastic economies which he loyally accepted. He employed me in working up his most critical cases and so taught me a great deal about the service problems of all ranks, while his tact in handling personal difficulties was a great example for all his successors. He also had all our textbooks completely revised, and by perfecting these and other professional details he left the Department far better equipped for the future than it had ever been before. All this was so quietly done that few people realize how much all subsequent development has owed to the sound foundations which he laid down.

Throughout the Department there was a real sense of loss when the time

came for his retirement, and this was strengthened by the feeling that his outstanding services had not been adequately recognized. That knighthoods should have been given to three of his contemporaries (his predecessor, his successor and one other officer), *but not to Ryder*, was just "one of those things." His pension was also cut down (as for some other seniors) by a military ruling of 1905, which made it impossible for any officer in the Survey to attain the rank of Major-General, whereas there were two Major-Generals in the Department when I joined it in 1898.

These were, however, small things when set against the happy background of his personal life. At the age of twenty-four he married Ida Josephine, the beautiful daughter of Lieut.-Col. E. E. Grigg, and they had six children and several grandchildren to carry on their fine tradition. His three daughters married into the army, like their forebears. His youngest son, Commander R. E. D. Ryder, V.C., R.N., was a polar explorer, and won the V.C. while leading the attack on St. Nazaire in 1942. His two elder sons, in the army, may have equally deserved it, since one was last seen holding an impossible rearguard position in France in 1940, while the other disappeared with his unit in the loss of Singapore. They were both married.

I have not met any of the family since 1939, but through many years of contact all my memories of them are very happy ones. Their many friends must feel deep sympathy at the great loss they have suffered by his death, last July, at the age of seventy-seven. E.A.T.

Colonel C H D Ryder CB CIE DSO

Maj-Gen Sidney H Powell CB

MAJOR-GENERAL SIDNEY H. POWELL, C.B.

ON the 15th December, 1945, Sidney Powell fell quietly asleep and in his sleep his soul passed gently away. It is not easy to write suitably of a friend whose death tears great rents in the veil that grows round the past, through which memories pour. " He was my friend, faithful and just to me." Few men more richly earned the epitaph from those with whom he was thrown in contact, than Sidney Powell, for staunchness and fair-dealing was the very essence of his being. He had outlived most of his contemporaries in the service, and the 22 years of his retirement had seen most of those who had been closely associated with him finish their active service. In the army of today he can be little more than a name. Yet he deserves to be recalled to mind, for he had held high appointments and his influence, quietly and unobtrusively exerted as was his whole character, had been great. He was not ambitious either for advancement or for recognition of his work. He set his own standard for himself—a very high one—and most faithfully lived up to it. He had a keen and accurate sense of values both in literature and in art. At one time he delved deep in the study of oriental philosophies. I can recall long nights over camp fires when he could be induced to give the results of his cogitations, but these were rare occasions. Generally he was content to retain, without any desire to impart, the knowledge he had gained. He never sought the limelight, indeed he shunned it. Twice in his service he declined the offer of appointments with high prospects of advancement, so that he might serve where he himself thought his service would be most useful. In his retirement it was, I think, his proudest reflection, that he had never asked for any preferment nor even volunteered for any office.

His schooldays were passed—in the distinguished company of Stalkey and Co.,—at Westward Ho! whence he passed at the top of the list into the R.M.A. Much of his service was spent abroad, and his career is a good example of the variety of experience of service in the R.E. of his time. After the customary training at Chatham, he was sent to India to join the Military Works Service at Kirkee. A year later he was on the frontier and saw active service with the Miranzai Field Force as Intelligence Officer. At the end of his first tour of Indian service he reverted home, but a long dull year with a depot company at Chatham sent him, on promotion to Captain, speeding happily back to the Indian frontier and to the commencement of his long association with the Bengal Sappers and Miners. He commanded the 2nd Company on service in Waziristan, with the Tochi Field Force and in Chitral, and later was appointed Superintendent of Park and for a brief period held the command.

As interludes in his Indian service, he spent a year at Aldershot, where he first made contact with Army Signals as O.C. of the Telegraph Battalion R.E., and two years in Egypt under the Sirdar with the rank of Kaimakan, at the end of which he was offered, but declined, the position of Director of Works in the Soudan. A little later he was offered but again declined the appointment of C.R.E. of the Cavalry Division at Aldershot. The years that he spent with the Sappers and Miners he called his period of greatest service happiness. Eventually, in 1910, he was appointed Commandant, the post which of all others he most desired, but, before he took it up, he was ordered to Army Headquarters in India to join the General Staff and take charge of the organization of the new Signal Service about to be formed in India. He threw himself heart and soul into the task, and the new service owed much to his work, which had its acknowledgement when, in 1934, he was appointed Colonel Commandant of the Indian Corps of Signals. He

was still at Simla on the outbreak of war in 1914, and it was not until the following year that, at the request of Sir D. Haig, then Commanding the 1st Army in France, he was sent to take charge of the Signals of that formation. A year later he was promoted to Chief Engineer of the 13th Corps, which he held until his health gave way and he was transferred home to become the Chief Engineer of the Home Forces. When the Home Forces Command was abolished, at the end of the war, he was appointed Chief Engineer of the Scottish Command, from which he retired in 1923 on attaining the age limit.

No brief memoir can do more than give a glimpse of the real personality of its subject. The conditions in which Sidney Powell served are so widely different from those of today, that it is hard, now, to realize the influence a man of marked character exerted on his associates. Each one's stage was smaller. We drew our experiences from more restricted sources. Each impinged more sharply on his fellows. Possibly in those days, a man like Sidney Powell, by example more than by precept, stamped his impress on others more clearly than now. Certainly to mention his name then to those who knew him was to recall a man of unswerving faithfulness, to high ideals, of great attainments, of rare unselfishness and of strenuous endeavour.

A brother officer—not many years his junior has written of him :—

" I have known him in the service since I was a young subaltern at Chatham and he a Captain. . . . During that long period I have never been out of touch with him and I can say that I have never known a man of finer character, of greater integrity and loyalty to the Corps and the service, or one less self-seeking. His intellectual powers and practical efficiency were outstanding. To acquire his friendship and respect were prizes worth having. Withal he had a capacity of genial companionship and a great, but subtle, sense of humour which softened and relieved any tendency to excessive seriousness which a man of such a character might develop. His marriage, rather late in life, was the greatest good fortune he ever enjoyed and deep sympathy will go out to his wife from all who have the privilege of knowing her, and to his daughter."

J.C.

BOOK REVIEWS

THE PROBLEM OF SECURITY

By Lieut.-General Sir Giffard Martel, K.C.B., K.B.E., D.S.O., M.C.

(Michael Joseph, Ltd., 26, Bloomsbury Street, London, W.C.1.)

Price, 10/6

PENDING the formation of a World Federation, Gen. Martel considers we should aim at developing some form of European Federation, so as to bring peace to the continent from which most of the big wars have emanated. We should organize our Imperial Forces as one army, and above all maintain our sea and air communications as the rock of the Commonwealth on which a system of world peace may well be built. He then gives details of how the Empire defends itself, and the part therein played by the Committee of Imperial Defence. The present system has on the whole worked well, but in the deliberations of the C.I.D. the Dominions have not had proper representation. To meet this difficulty, he suggests the formation of a Commonwealth Council to discuss questions of defence and to advise the governments of the Empire accordingly. To ensure closer liaison he advocates further that some of the staff appointments on the C.I.D. be filled by officers from the Commonwealth. The tentative conclusion reached as regards the strength required is that we should have first-class naval and air forces, backed up by a small but highly trained mobile army, and that the advent of the atomic bomb does not, for the present at all events, alter these recommendations.

Discussing the question of choosing our military leaders, Gen. Martel is somewhat severe on some of our commanders at the outset of this war. It would have been beyond the capacity of any military genius to have won victories for us in Norway, France, Greece, or S.E. Asia, with the meagre troops and equipment available. In fact any senior fighting general who commands a British Army at the beginning of a war takes his reputation in his hands, with the only certainty that he will be opposed by considerably superior forces. The author is in favour of a school for leaders, such as was started at Minley Manor prior to the war.

This is very sound, as nowadays it is more than ever necessary that the selected officers should live and work in close contact with officers of the other branches of the service, as well as with naval and air force officers, so that we shall not lose that wonderful co-operation between all arms, which gained us the final victories.

Nobody will disagree with the proposal that younger officers are required in the higher ranks, but a big reduction in the age limit would entail a large increase in the burden of retired pay—old soldiers never die—and Treasury sanction would not easily be obtained. In his chapter on Organization the author harps on decentralization, and the stranglehold that the detailed financial control of the War Office imposes.

Of great interest is the history of the development of the tank since the famous attack at Cambrai in 1917 proved their worth. Apart from differences of opinion among senior officers of the Tank Corps, the formation of an armoured force of all arms and their training were delayed by lack of funds.

This stringency was due not only to the financial crisis, but also because the government of the day did not anticipate a European war for at least another ten years. When about 1936 this period was arbitrarily reduced and funds were made available, it was too late to make up leeway, and the General Staff never realized their hope to form a mechanized striking force of four or five divisions and one armoured division. The presence of such a force in France in April, 1940, might have had far-reaching results.

Just as the tank is undoubtedly of British origin, the author claims that armoured fighting tactics are based on British ideas, and as a proof quotes a lecture on the subject delivered by him at the R.U.S.I. in January, 1937. German tank tactics have been ascribed by some to General de Gaulle's book—probably the Huns drew inspiration from both these sources.

One lesson for reconstruction is emphasized, i.e., that at every stage of experiment the General Staff of the army should be certain that there is one model of every munition of war ready for mass production, if war becomes imminent. We were not prepared in this respect, especially as regards the tank.

In the last chapter on the "Problem of India," three very cogent reasons are given for arriving at the conclusion that Britain should remain in India as the paramount power. This is probably the view of most officers who have served in India, but it is not likely to carry much weight, as few of the people who decide the policy on India have lived in that country.

It is difficult in a short review to give a summary of the many varied and interesting questions dealt with. Many of the views are based on work done in conjunction with other officers some ten years ago and have proved correct. This book will repay careful study as the problems involved are of vital interest to the Empire.

Gen. Martel remarks that Britain is almost completely ignorant about India and Russia. He has dealt with India and we look forward with pleasure to his forthcoming book giving his impressions of Russia. He may help to debunk the popular fallacy that Russia is a democratic paradise.

C.G.F.

NEW GUINEA DIARY

By George H. Johnston

(Published—Victor Gollancz, Ltd., London—10/6.)

A statement found early in this book tells the reader that Japan had, with the capture of Rabaul on 23rd January, 1942, for the first time advanced and conquered South of the equator; she had in a few vital hours captured one of the greatest natural defence points and naval bases of the South Pacific. Only one Australian base stood between Rabaul and the Australian mainland —the little garrison of Port Moresby, on the south coast of Papua (page 11).

New Guinea Diary opens on that very date and concerns itself with the next twelve months, concluding on the selfsame day in 1943, when the Buna area was finally captured and cleared and, to quote—"the last Japanese soldier in Papua had been killed or captured." This book, therefore, covers the landing of the Japanese in Papua at Gona, their advance over the Owen Stanley Range to within 30 miles of Port Moresby, and the manner in which they were stopped and finally driven back, thus assuring the safety of Australia.

A great deal is said about the almost entire absence of both land defences at Port Moresby and of air support in the early days of Japanese aggression.

A picture is given of the build up of Australian and American Air Forces until complete air supremacy was attained; some good tales (mostly American) are included, which the author obtained from pilots and air-crews, and a fine picture is painted of the purpose, guts and will-to-win of the Allied airmen. It is possible from this book to gain a very good view of the air situation, of the country that had to be flown over, of the machines and of the men who flew them and maintained them; but, on the other hand, it is not at all so possible to piece together the military picture and to follow out how the plan to defeat invasion was made and carried through to such a successful conclusion. The original land forces were the New Guinea Volunteer Rifles and Papuan Infantry Battalions (native), they were followed by A.I.F. from the Western Desert and finally the American Army joined in too. There are some excellent stories of how the soldier lived and fought, the terrain, almost his greatest enemy, is described so that it really does tell something of the appalling reality that it must have been, but it is not possible to escape a feeling of disappointment that so much of it should be second hand and so very little of it seen at absolute first hand; nevertheless there is much of real interest and value to be got out of the book.

War correspondents, whatever their literary accomplishments, are not always the best of authors or historians. It is not possible for one person to be on hand when all the best incidents take place, but his newspaper wants to know about them; besides the war correspondent must be within reach of communications so as to get his news away, and he must have the tools of his trade with him, both these factors prevent him from being a real front-line man, therefore he has to get his personal stories and much of the colour from the wounded or from amongst reserve units; on the other hand he is too close up to be in touch with the bigger picture or to be able to see his campaign as that part of the whole which in fact it is. The result is that this book or "Diary" as it is named, does not run smoothly, either as a narrative of events or as a general picture of the New Guinea campaign; but, nevertheless, it does tell of many things which are undoubtedly not so well known as they should be. In his Note or Preface the author warns the reader that his book is neither a detailed day-by-day account of events nor a campaign history; it seems a pity then that this most interesting book should have been written in diary form and named *New Guinea Diary*—method and title are both misleading. Paper restrictions are responsible for much, but can hardly excuse the one and only, very poor, sketch map with which the reader is provided; better value will be obtained when reading the book if a good reference atlas is kept handy.

This book was published in 1943 and it is now 1946, but surely even in 1943 (or did "Security" forbid) this tale would have been better if linked up into its rightful place in the Japanese War as a whole. The author states that General MacArthur, General Blamey and Major-General Kenney (by then C.-in-C. Allied Air Forces, S.W. Pacific), all had their headquarters in New Guinea by the time that the Papuan offensive started late in September, 1942—a good enough pointer to the extreme importance of the New Guinea campaign within the framework of the War against Japan as a whole. Was not the clearing of the Japanese from Papua a key move, or one of them, in the relentless plan which first halted and then forced the enemy from the offensive to the defensive and which marked the beginning of the end for Japan. That, at the same time, Australia was freed from possible invasion, is, of course, equally true, but time has shown, and will show even more in the future, the full importance and significance of the Japanese repulse in New Guinea.

B.K.Y.

THE QUEST OF LEADERSHIP

By Colonel Donald Portway

(Published Thacker & Co., Bombay, Rs4/14/0, 8vo., pp. 142.)

Colonel Portway needs no introduction to pre-war officers of the Corps. Anything from his pen is likely to be characterized by original thought and a lively presentation. The small volume under review is no exception.

Published in India, where Colonel Portway has been employed in the Army Selection directorate, it deals with the selection and training of those leaders whom India so desperately needs if she is to ensure an adequate political, social and industrial future. This is not to say that the book is not of value for the Army at home. The chapters on Intelligence Tests on Interviewing, and on Examinations are of general application. And even the severe strictures, which Colonel Portway finds it necessary to make on the conditions of education in India, are uncomfortably pertinent to much of the public education in this country.

Colonel Portway has had great experience both as a tutor at Cambridge and with the Army Selection directorates, both at home and in India, and he applies to his experience an acute and cultivated mind. His book is no mere compilation but an original contribution to a subject which is of vast importance to the Corps, especially now that the net is likely to be spread so wide. The chapter on Interviewing is perhaps the most interesting; but the whole book can be read with pleasure and profit by all officers who are likely to be concerned with the selection and training of the Royal Engineer in all ranks and trades.

L.V.B.

IWO JIMA

By Five Official Marine Combat Writers

(Published by the *Infantry Journal*, U.S.A. Price 25 cents.)

Iwo Jima, a small volcanic island, was an essential stepping stone to the attack on Japan itself. The importance of the island had been fully realised by the Japanese, who were determined to defend it to the death, and had done all that was possible to make the island, which was naturally a splendid defensive position, into what they considered to be an impregnable fortress.

Besides concentrating a tremendous number of guns and mortars, the latter up to 320 m.m. in size, the hilly centre of the island had been tunnelled out into a veritable rabbit warren, with innumerable gun, mortar and machine gun positions dug into the hillsides and firing through narrow slits, which made them practically invisible.

Air attack was of little use against such defences, and flame throwers and explosives were the surest means of dealing with them. All positions were interconnected underground, and as soon as one "earth" was stopped the Japs appeared at another.

It was in these conditions that a force of 60,000 American Marines lost 20,000 of their number in killed and wounded, in the 35 days of fighting which were necessary to clear the island.

The book is illustrated with a large number of excellent photographs, which give a good idea of the difficulties of the terrain. Some very clear sketch maps show the progress of the American troops during the fighting.

C.C.P.

MAGAZINE REVIEWS

GEOGRAPHICAL JOURNAL

(Published by the Royal Geographical Society, London.)

March–April, 1945. In *The Northern Highway of Peru* Christopher Sandeman gives an absorbing account of a journey down the Huallaga (one of the head waters of the Amazon) to Yurimaguas and back to the coast by the old northern highway. The variety of the journey is shown by his means of progression—raft, dugout canoe, foot, muleback and car; and the hazards and discomforts by the mention of rapids, whirlpools, mud, tracks too steep for mules, and vampire bats. A pleasing touch occurs on the car journey, when a small boy travelled on the step carrying a large stone, which he placed behind the wheel when the car was backed to the edge of an abyss to allow it to get round the hairpin bends; the driver remarking "Fear not! The car is ancient, but the brakes should hold."

Capt. J. W. Wright, R.E. contributes an article on survey work with the Sudan Defence Force in the Libyan desert, 1941–43, when he was able, in spite of frequent interruptions and obstacles, to get some valuable work done. He gives an interesting description of the methods adopted to suit the peculiar conditions.

William Courtenay, who was a war correspondent at General MacArthur's Headquarters, gives a graphic description of operations in the Pacific theatre. It is interesting to note that the Japanese never achieved any tactical surprise on land after Pearl Harbour, but were continually out-manœuvred and out-generalled.

Michael Terry gives an account of "Soil Erosion in Australia" and of how the problem is being dealt with.

There are obituary notices of the late Secretary, Mr. A. R. Hinks, by G. R. Crone, Sir Charles Arden-Close and Professor Kenneth Mason.

May–June, 1945. This number includes the address of the retiring President, Sir George Clerk, at the Annual General Meeting.

There is a most interesting account, the subject of an afternoon paper, by Russell Lord, on the effects of soil erosion in the United States, and the measures taken to repair the damage done. A point that comes out is that there is nothing new in the methods now being adopted. As a shrewd American remarked, "It isn't what we didn't know, it is what we had forgotten."

In this connexion it is noticeable how this problem of soil erosion is cropping up in widely distant parts of the world. In the last number of the *G.J.* an article dealt with the subject as it occurs in Australia; and it is even happening in parts of this country, in a minor, but by no means negligible, degree.

W. H. Ward discusses *The Stability of Natural Slopes* in a well illustrated and informative paper.

Lieut. P. C. Spink gives an interesting description of *Thermal Activity in the Eastern Rift Valley*, as evinced by a quantity of steam vents in a roughly north and south line in the neighbourhood of Lakes Elmenteita and Naivasha.

Among the reviews is a good account, by G. R. Crone, of the new (sixth) edition of the O.S. 1 inch map, with the new metric National Grid.

E.M.J.

EMPIRE SURVEY REVIEW, October, 1945

(Published by the Crown Agents for the Colonies.)

Sir E. Dowson and V. L. O. Sheppard continue their account of the Cadastral Survey of Egypt, describing the events which led up to the establishment of the Survey Department under Lyons in 1898, with technical details of the cadastral work carried on under his direction.

Brigadier Winterbotham discusses the various factors affecting international boundary delimitation in the light of modern conditions and gives some useful information on recent literature on the subject.

A. V. Lawes describes technical details of *Cadastral Traverses in the Gold Coast.*

L. P. Lee investigates McCaw's expressions for coordinates of a point on the Transverse Mercator projection, and concludes that McCaw's methods were in error and that the Gauss method is correct. E.M.J.

AN COSANTOIR

Journal of the Eire Army.

September, 1945.—The biography this month is a first instalment only of *Liam Lynch* who held various important positions in the I.R.A.—covering the period 1917–21. Some of the work of raising and organizing the units in Central and S.W. Cork is described as well as a number of interesting "incidents."

A number of reprints from U.S. sources, including two originally Russian, comprise most of the rest of the issue

Battalion Surgeon outlines the duties of the M.O. with forward troops in action; "The Difficult Art" deals with leadership and contains nothing really novel though the fact that the author is an (American) Sergeant puts the case from an unusual angle.

Rockets and their capabilities is little more than a survey of what has already been developed to the stage of actual operational use. "New weapons for New tactics" also is mainly concerned with weapons already produced though obviously capable of improvements: the author does, however, suggest the production of a light M.G. which would fire only special incendiary bullets, for use as an alternative to the smaller flame throwers.

Preparing the Mind for Battle deals with the incidence of casualties from "nervous exhaustion"—the modern name for the last war's shell-shock case, now recognized in its early stages before it is really serious. It points out from experiences with a unit through N. Africa, Sicily and N.W. Europe, how physical fitness and battle inoculation enormously reduced its appearance—and how it cropped up with experienced men only when they had been reduced to a state of physical exhaustion by long and hard fighting.

Battle Formations—from the Russian—seems to say a lot without telling you very much. The emphasis on organization in depth is of course nothing new, but it is obvious from the extent to which it is carried that possible shortages of man power or artillery are not taken seriously. "In Military Doctrine of the Russian Army" (also from a translation) the same atmosphere of the availability of numbers is again noticeable.

D. R. ff.M.

THE ENGINEERING JOURNAL

(Published monthly by the Engineering Institute of Canada.)

August, 1945.—An interesting article deals with *The Canadian Universal Trestle*, to provide intermediate supports up to 35 ft. high for the standard Bailey, or other types of superstructure, in wet or dry gap locations. A saving of weight of 76,000 lbs. is instanced on a 140 ft. span with a Class 70 bridge. Methods of launching are described.

Oil for Defence and Attack forms the subject of a short paper.

The uses of oil for smoke screens, blazing beaches and fog dispersal are briefly dealt with. The bulk supply system (including Pluto) used in the 1945 offensive, is also referred to.

Interesting articles also appear on the following subjects :—

The Manufacture of Propellers for 18 inch Torpedoes.

War Time Equipment Responsibility of the Royal Canadian Corps of Signals.

An Outline of the Preliminary Steps in Community Planning.

September, 1945.—*The Atomic Bomb and Canada's Contribution to it. Uranium fission plant.* Plutonium (the fissile material used in one of the Japanese bombs) is produced in Canada by a method involving the use of uranium metal and heavy water, while the U.S.A. has concentrated on two other methods of producing fissile material. The general use of atomic energy for industrial power appears remote. The greatest possibilities lie in the medicinal use of the large quantities of radio-active materials produced as by-products.

Japanese Paper Balloons.—These ingenious devices floated eastwards in the upper atmosphere from Japan and some 300 landed on the American Continent. The bomb load carried was less than 100 lbs. and the damage caused was negligible.

Articles on the following subjects also appear in this issue :—

Water Wheel Generators. Modern construction practice in the United States.

Battle of the Scientists. How the Magnetic Mine was mastered.

Diesel-Electrics in Industry and Transportation.

Pollution Hazards in a Water Supply System (with particular reference to the City of Montreal's experience).

Engineering Investigation of the Water Resources of the Columbia River Basin.

October, 1945.—*Semi Permanent Bridge Construction by the Canadian Army in the European Theatre of Operations.*

This article deals with the construction of Rhine bridges at Zutphen and Arnhem, one Class 70 and one Class 40 at each place. Standard Bailey components were used for the superstructures with wood piles at Zutphen and steel box piles at Arnhem. The bridges (one 1,450 feet and the other 1,250 feet long at Zutphen and both 2,250 feet long at Arnhem) were built in about 6 weeks (April 15th to May 28th, 1945) of continuous day and night operations. The number of men employed never exceeded 1,300 at either site.

Fog Dispersal from Airstrips. Development of "Fido" (Fog—Incendiary Dispersal of).—Various types of burner and installation are described (mainly petrol burning) but experimental diesel installations are briefly referred to.

The following subjects also are dealt with in this issue :—

12,500 Kilowatt Steam-Electric Station of Nova Scotia Light and Power Company, Ltd.

Unification of Screw Threads.

W.M.

JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA.

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

July, 1945.

Financial Control and Paper is a valuable attempt to reduce the burden which audit brings on the army, with special reference to India. The author shows clearly that control is very necessary, and in his preliminary remarks there are two interesting facts; firstly, that the Auditor-General, once he has completed his tenure of office, is debarred by law from holding any other office under the Crown, and secondly, that the salary bill for financial control, pre-War, worked out at the cost of 21 battalions of infantry. The author's solution is to trust officers in administrative posts to use their financial powers wisely and well. The financial veto should give place to financial advice, but there must be good men to give it.

The Red Army.—Foundations of Strength.—A vivid description of how the fighting spirit is maintained in the Russian army, even by such methods as carrying regimental colours into battle. A disquieting feature is the almost complete absence, in army and regimental newspapers, of any references to the share which British and American forces have had in winning the War.

The Sepoy overseas—and at home.—The main point made in this useful article is the need for interest by the Indian Legislature in the welfare of the Indian soldier.

Further Notes from Britain includes one on the formation of a club "The Allied Circle" comprising members —men and women—of every allied European nation. It seems to be doing useful work, especially in making known the views of Continentals. Russians, by the way, are not allowed by their Government to join.

The question of the education and selection of King's Indian commissioned officers, who form an increasing proportion of the cadre of the I.A., receives careful treatment in *Officers of the Post-War I.A.* The author recommends the retention of Viceroy's commissioned officers, *risaldars*, *subadars* and *jamadars*, as at present, at any rate for a considerable time, as the ambition of the average sepoy rarely reaches higher than these time-honoured ranks.

The Gunners at Kohima gives a good account of the defence of that post, which by all the rules of war should have been untenable. Many of the gunners were employed as infantry.

The author of *The Prevention of War* lays stress that there are now only three great powers in the world, and that therefore there is less chance of trouble. It is of course easy to criticize any scheme for the preservation of peace, but before war can be stopped, we must have a definition of war, and no logical definition can be made which excludes perfectly legitimate action in the defence of the civil power, and say, the General Strike of 1926, where a minority sought to impose its will on the people by withholding supplies. A vast change must take place in human nature before war becomes impossible, and it is only the Christian who has, or ought to have, a programme for bringing about that change. The prevention of even small wars has so far proved impossible, and until a fair measure of success has attended efforts to suppress such, it is futile to talk of preventing bigger ones.

A Letter to Mars describes the I.A. of 1960. Class and class company regiments have disappeared, and the only concession to messing prejudices is that every unit has two cookhouses, one with and one without meat. The V.C.O. has disappeared. British officers there are, but such are seconded from the Home and Commonwealth armies. Altogether an article well worth reading.

Japanese Mines and Booby-traps is by Capt. W. D. Bristow, R.E. These gins suffered from a defect which the enemy took some time to realize, namely, that they were not powerful enough. One invention, the daughter of necessity and paucity of safety fuze, consisted of ordinary rope suspending a brick over a primed bomb. A Jap lit the rope and then ran for life, while the rope gradually burned through and let fall the brick on to the detonator.

The Frontier Myth will certainly evoke a good deal of criticism. Briefly stated, the author claims that political influences (very necessary) limit the occasions on which the soldier on the N.W. Frontier can be anything but on the strictly defensive. "Troops and officers steeped in frontier training are liable to be excessively cautious, timid in patrolling, ignorant of modern tactics, unfit physically and horrified of heavy casualties."

Sisters in Need relate the sterling work done by members of the *Fauji Sevadarni*, whose task it is to visit the homes and enquire into the grievances of the families of men on service.

Permanent Peace—through the Children proposes that the young of our enemies, from five years old and upwards, should be removed from their parents and given an internationally-minded education. A tremendous scheme, but, we may ask, where are the teachers to come from and who is to pay them? Moreover, few will agree with the author's proposal to put Japanese children under the Russians. F.C.M.

THE INDIAN FORESTER

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

July, 1945.—*Soil stabilizers*, in use on runways in aerodromes in India, where tarmac and concrete are not always available, are found to produce an abnormal growth of certain plants present in the soil. Experiments are being carried out.

Many numbers of the *Journal* recently have contained articles on future forest policy and planning, and this one is no exception. The editor rather plaintively remarks "it will be interesting to hear in due course what has actually been achieved."

August, 1945.—*Forests and Woodlands in Sind* concludes the account of a comprehensive plan for the regulation of existing, and planting of new, woodlands. Large parts of the desert and hill tracts can be partially stocked with trees, and swampy areas can be reclaimed. More use might be made of P.W.D. estates, roadside trees, etc. The scheme proposed will cost money, but it has been proved over and over again that good forest management pays.

The place of Mechanical equipment in Indian soil conservation contains an interesting suggestion, namely, that since so many sepoys have now a sound training in driving and maintaining M.T., they should be employed in driving machinery for bringing waste land into cultivation. They could be retained in a Pioneer Corps until this desideratum was obtained, and then settled on the land which they had helped to reclaim.

Col. J. C. T. Willis's article "What Book?" in the December, 1944, *R.E. Journal* is reproduced at length.

September, 1945.—Commenting on the necessity for providing wood for fuel for villagers, in place of the almost universally used cowdung, a contributor estimates that a village of twenty families, or 100 heads, will need a plantation of 10 acres of *shisham* or *babul*. This ought to supply 500 maunds (366 cwt.) of fuel *per annum*—a ration of a little over a pound a person a day.

F.C.M.

THE MILITARY ENGINEER

(Published by the Society of American Engineers.)

August, 1945.—*Engineering Operations on Advanced Bases* by Col. A. L. Lane. This article, covering Engineering problems encountered in some forward S.W. Pacific bases, gives the author's views on the more important points, included amongst which are the following.

Advance planning, before landing, is of vital importance ; for this purpose maps, which very often have to be made from aerial photographs, are essential.

After landing, thorough ground reconnaissance to check the advance plans must be made at once.

Good roads are vital to the economical working of a base. It may often be real economy to re-align existing roads to a series of straight tangents connected by easy curves so as to reduce casualties among vehicles. A shortage of vehicles brought about by traffic accidents may spell disaster to a major operation.

The fullest use must be made of local materials, this usually calls for special equipment, such as power saws, its early provision must be arranged.

As in every kind of operation the bogy of " Order, counter-order and disorder " must be kept at bay by continuous contact between Engineers and all other branches of the Service.

Repair of Railroad and Highway Bridges in Luzon by Major W. W. Dillard. This gives a description of the work done on partly demolished bridges.

The Railroad bridge originally was carried by steel latticed girders of 50 ft. spans supported on steel caissons. The road bridge by steel trusses on concrete piers ; damaged members of three of these trusses were replaced by parts salvaged from two others which were wrecked, the gap originally spanned by these two was bridged by means of timber supported on piles.

The article gives only an outline of the work done, it is well illustrated.

Hurricane Effects on Military Structures by Col. A. H. Bond describes what happened to " Theatre of operations " type buildings in the West Indies during a tropical cyclone-type storm.

Details of the buildings are lacking, apparently they were not specially designed to resist cyclones, but, on the whole, they stood the strain.

Falling trees were responsible for practically all the damage they suffered, and also for damage to electric lines.

The importance of keeping stocks of materials for repair of roof coverings and overhead power and communication lines is stressed.

Over " The Hump " into China by Dr. E. G. Mears, President Association of Pacific Coast Geographers, carries one step further than the article in the February issue a description of the terrain in and north of Burma. In this case the country dealt with is that across which an airborne transport service between India and China was maintained.

September, 1945.—*Rhine River Railroad Bridges* by Major-Gen. C. R. Moore, Chief Engineer European Theatre of Operations.

This article gives the history of the operation of building these railway bridges.

Planning was begun in October, 1944 ; this included " Special Engineer Studies " on geology, hydrology, navigation and many other factors. As a result of these studies standard typical pile bridges were designed as a basis for determining stocks of material and equipment required ; the final detail design and planning were left to the Groups who were charged with the carrying out of the work. A general description, illustrated by some good photographs, of the work done is given.

The claim that this work was one of the most outstanding military achievements in the history of the Corps of Engineers seems justified. The British Royal Engineers also built a railway bridge over the Rhine, which is described on page 62 of this issue.

Rhine River Flood Prediction Service by Lt.-Col. S. W. Dziuban gives the story of the establishment and operation of this most important service.

The object was to permit, firstly, the best selection, from the point of view of river conditions, of the date and time of assault, and, secondly, the taking of measures to protect floating bridges and other material.

Two photographs of the same stretch of river, one at normal stage and the other during flood stage, show clearly how necessary this service was.

Mapping the South Pacific by Sergt. C. G. Curtis and Pte. L. Grolnick gives details of how the maps, the necessity for which is insisted on in the article Engineering Operations on Advanced Bases in the August issue, were made.

October, 1945.—*Military Applications of Photo-Geology* by Ist Lieut. R. D. Dirmeyer, Jr. This article is yet another dealing with aerial photography and shows how the application of geological knowledge can extract from aerial photographs information required in planning and carrying out military operations.

A point is made that the best use of such information is in the pre-landing planning and that such prior reconnaissance, though it cannot take the place of work on the ground, generally saves many hours of trudging around on the ground.

A list of some of the engineering problems which lend themselves to this study is given; this covers a wide field of probable activities. Examples of how this was made use of in the Pacific are given.

Aviation Engineers in Guam by Lieut.-Col. H. E. Brown, Jr. tells the story of the development, in seven months, of one of the world's largest airfields by an Aviation Engineer Battalion.

Some idea of the magnitude of the task can be gleaned from the following extracts from details given—847 acres of jungle cleared; airfield surface of 1,595,400 square yards formed; used enough lumber to build 63 small family dwellings; constructed a 750 bed Hospital.

The article concludes with these words. "Yes, it was an engineer's dream that did come true."

The Military Significance of Martinique by Dr. J. K. Eyre, Jr., who received a Ph.D. from the University of Michigan, "majoring" in political science and specializing in the field of foreign affairs. This article draws attention to the important part that Martinique has played in history, not only of the Western hemisphere but also of Europe; in view of the trend of present day wars to be global affairs it is likely that this island will continue to be strategically of great importance.

One interesting point brought out is the way in which it has affected British affairs, e.g., during the "American Revolution," more commonly called the War of Independence, Martinique was a thorn in the flesh of the British, and in the beginning of the nineteenth century it was planned to be the base for the invasion of the British Isles by Napoleon.

The U.S.A. is nowadays vitally interested in the ownership of Martinique, with its magnificent harbour, in view of its position with regard to the Isthmus of Panama. A.R.A.I.

INFANTRY JOURNAL

(Published by the U.S. Infantry Association.)

August, 1945.—This issue, which is devoted entirely to the War in the Pacific, starts with an article entitled *Japan Explains her War*, by Maj. DeWeerd, which discusses the propaganda put out by the Japanese. This was most crude, in many cases inconsistent and in some cases so deliberately false as to report serious defeats as Japanese victories. Each successive American advance was stated to be an opportunity for final Japanese victory. Such methods cannot but fail in the end.

Hacksaw Ridge by Capt. L. K. Soth is a description of the extremely difficult fighting, which occurred so often in the Pacific, when the Japs held a ridge or hill which was completely honeycombed with tunnels and dugouts.

The Naval Strategy of the Pacific by Lt. B. Brodie, U.S.N.R., is a very clear statement of the growth of American naval power in that theatre. It shows for the first time how near defeat we were in August, 1942, during the attack on Guadalcanal, when owing to lack of aircraft carriers we could not provide any bombardment from the sea for the landing forces nor give them air cover. During 1943 the American Navy was being rapidly built up in all types but especially in aircraft carriers and the fleet supply trains. Eventually in 1944 we obtained a complete and overwhelming superiority over the Japanese which enabled the American forces to be landed nearer and nearer to the Japanese mainland and finally enabled the Navy to bombard the Japanese coast with practically no interference at all.

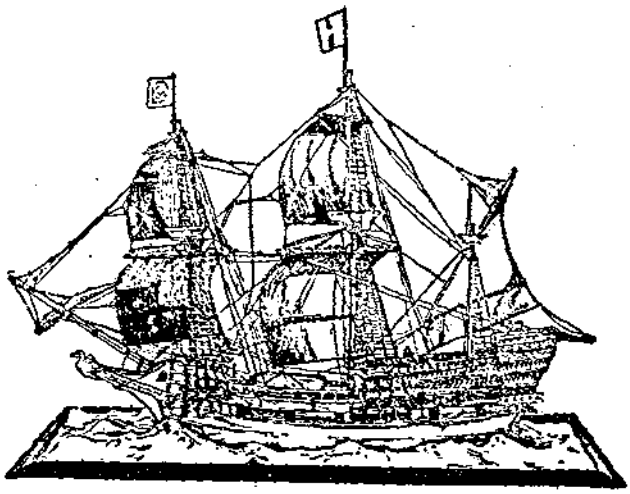
September, 1945.—*Jungle of Stone* by Tech. Sgt. A. M. Josephy gives a very good account of the difficulties of the fighting on Iwo Jima. Part of the island consisted of a mass of rocky hills, all honeycombed with tunnels. As fast as one portion appeared to be cleared the Japs came to life again, and the whole area took many days to clear after the main battle had advanced many miles further inland.

Dig, Drain, Ditch by Master Sgt. Jim Connell gives a few very useful tips to all soldiers about keeping roads passable. He starts off with a very true statement, not always realized by those who are not engineers, that " Neither God nor Fort Belvoir ever made enough engineers to take care of every road in an army area." He then describes some of the simple methods by which others can help, the two most important of which are to dig drains to get rid of the water and that all drivers should keep to the ridges and not the ruts.

October, 1945.—*Sweeping* by Maj. I. Heymont gives a brief picture of the final advance through Germany to link up with the Russians. There was no real organized resistance, although many German detachments, well supplied with 88 mm. guns and ammunition, fought till the last round. The main difficulty was transport to get the infantry forward. A field artillery battalion carried the foot elements of an infantry battalion, and the vehicles of the anti-tank and cannon Coys. could do the same.

Science and Security by Dr. Vanneva Bush describes the necessity for co-ordination and planning of the scientific resources of a nation for war needs. The article stresses the importance of more scientific training of officers, especially for higher commanders, and a genuine scientific interchange between the services. At the same time it is essential that there should be a true and effective partnership between the civilian and military scientists.

C.C.P.



MEMORY *in* SILVER

THIS silver Ship is a worthy example of modern craftsmanship in precious metals. It is a model of Drake's *Golden Hind* as she was originally designed and named *Pelican.* In this little ship of something over 100 tons Drake circumnavigated the globe and it was in her cabin that he was knighted by Queen Elizabeth.

LITTLE ships have ever played their part in Britain's sea triumphs. The memory of the modern "little ships" which contributed so much to victory deserves to be as worthily perpetuated.

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