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THE ROYAL ENGINEERS JOURNAL

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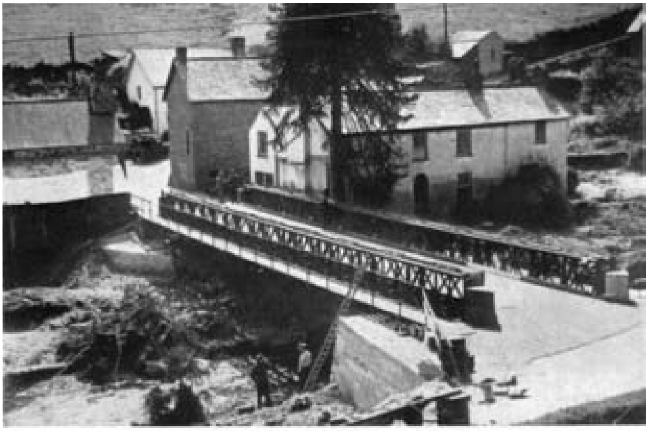


A general view of the bridge at Barbrook in which the work done to the abutments can be seen. Note the " high-water mark " on the white cottages.

The Barnstaple-Lynton road showing the very restricted building site, and the cramped space for stacking bridging stores.

The Barbrook Bridge 1,2

THE BARBROOK BRIDGE

OPENING THE ROAD INTO LYNMOUTH AFTER THE FLOODS

By LIEUT.-COLONEL M. O'C. HORGAN, T.D., R.E. (T.A.)

EDITOR'S NOTE

A short general account of the work done by various R.E. units in the Lynmouth and district flood area was published in the October issue of the Sapper *and further pictures in the November issue. The following article gives some details of the organization and planning required in connexion with one particular item.*

TAKEN as a plain matter of fact, one would suppose that the erection of a 90-ft. double-single Bailey bridge hardly calls for comment, especially in a Royal Engineer publication. That is, of course, unless it has something unusual about it ; and the Barbrook bridge was certainly exceptional in the experience of a Territorial Engineer unit in peace-time. Except for the shot and shell and similar unhealthy concomitants of such proceedings in war-time, the whole operation bore a close resemblance to active service conditions which made it a most valuable piece of training, quite apart from the usefulness of the finished product.

Yes, they were all there—the Chief Engineer's conference, the warning order to troops, the reconnaissances, the move up to the site, the bridging material delivered from a rear dump by R.A.S.C. transport, and the full procedure of rendezvous, harbour areas, marshalling area, and so on. The site itself, about a mile upstream of Lynmouth, bore a considerable likeness to a war area after the disastrous floods of Friday, 15th August, had washed away the bridge leaving two badly damaged stubs of abutments, and had wrecked houses, gardens, walls and vegetation, filling the bed of the river with tangled debris.

True to type also was the incessant barrage of questions from would-be users as to when the bridge would be opened to traffic, for not only was there no possible road into the devastated village of Lymouth until Barbrook bridge was ready, but several square miles of country were completely cut off by road from the rest of England. Numerous holiday-makers and others, with their cars, were stranded in conditions which made holiday-making a mockery. This was, therefore, no carefully planned and rehearsed training scheme, but an urgent operation, coming—in most realistic fashion—out of the blue. The troops had not had weeks of schooling, but were a mixture of T.A. volunteers, of National Service men doing their part-time training and of Z-Reservists recalled only a day or two previously with several years of civilian life between them and their last soldiering. Many had had no previous experience of Bailey bridge work, though luckily a strong cadre had erected a Bailey bridge only a few weeks before on the Leatherhead by-pass for the Surrey County Council, as a week-end scheme from their training centre at Epsom. Little had they then realized how valuable that experience was to prove.

It all started on Saturday night by Commander 27 Engineer Group T.A. asking the C.O. of 121 Army Engineer Regiment if he had heard the B.B.C. news bulletin, which had given a preliminary report of the Lynmouth disaster. They were at Penhale Camp near Newquay with the advanced party of the Regiment which, with Group H.Q., Signals troops and R.E.M.E. detachment were to start their annual training there the next day. The main body duly arrived in camp next morning, and whilst the business of receiving, clothing and organizing some 700 Z-Reservists was in full swing, representatives were called to a meeting at Lynmouth. The Group Commander and the Regimental Commander left within the hour on the 120-miles journey, taking (happy thought !) kit for the night and plenty of sandwiches left over from the Z-Reservist's mid-morning lunch. The sandwiches were still being consumed at tea-time the next day ! Various military representatives attended an emergency meeting of the local council, and after a reconnaissance of the area, the County Surveyor decided that an emergency bridge, impossible in Lynmouth itself, must be put across at Barbrook. Since his long-term plan was to erect a permanent bridge at a near-by site, the existing abutments could be used, and the emergency bridge would have to continue in use for at least a year. As the nature of the valley precluded any other rapid bridging site, no immediate temporary bridge could be attempted and the isolation of part of the community by road for a week or more was accepted. The County Surveyor had available a local contractor capable of doing any necessary work on the abutments, but he called on the Military Authorities to erect the bridge itself. Chief Engineer, South-West District accepted the task and allotted it to 121 Army Engineer Regiment. The C.O. got in touch with his camp by telephone and instructed 316 Field Squadron to carry out the work, a reconnaissance party to report to him at the bridge site next morning. A preliminary survey was then made of the gap by the C.O. and the Group Commander, and the general lines of the bridge and the work necessary on the abutments were formulated.

On the arrival of the squadron party next morning a full survey of the site was made, the following being the more notable points :—

(*a*) The gap was close to a T-junction off the main road from Lynton to Barnstaple.

(*b*) The wing walls of both abutments had been largely washed away and would have to be replaced.

(*c*) The abutments had been so weakened that it would be necessary to put the bank-seats well back. This was also advisable to avoid undue constructional work, for the width of the previous roadway was 2 ft. narrower than that required to support the Bailey bridge bearings. On the near bank a limit was imposed by the turning circle required by motor coaches off the main road on to the bridge. A single span of 90 ft. was decided on.

(*d*) There was very limited space for building. The distance back from the bank-seat to the wall of a house across the Lynton road was 41 ft. 6 in. The contractor was instructed to preserve and strengthen the existing abutments right forward, regardless of the location of the bank-seats. If successful this would both add several feet to the building site and reduce the gap between the launching and landing rollers to a minimum.

(*e*) The only site for unloading and stacking stores was at the side of the main Lynton road. This limited the number of lorries on site at any one time to two, and necessitated closing half the road throughout the operation. For the building itself, the whole road (the only one into the area) would have to be closed.

(*f*) The flood had fractured a surface-water drain on the far side and a considerable flow of water from springs, etc., was flooding through the abutment filling. The source of this was eventually traced by using a bottle of Jeyes Fluid as an indicator. Both by smell and by colouration of the water, it worked admirably, even in quite small concentrations. The contractor was instructed to block the flow and divert it to the river through pipes at a fresh point.

(*g*) The handling of transport was a problem as it was well nigh impossible to get vehicles off the road from Barnstaple onwards. For harbouring, a stretch of road was discovered where they could be pulled on to the verge sufficiently to avoid impeding traffic, and a small area sufficient for four or five 3-ton trucks was found at the side of the road about 300 yards from the bridge site. A turn-round for empty vehicles had to be searched for, and a small gap for one lorry only was found just below the bridge site.

Before the party returned to camp on the Monday, several arrangements were made. Firstly a detailed plan was drawn out of the work required on both abutments. One of the party, an architect in civil life, produced first-class drawings in the back of a 1-ton truck, and these were given to the contractor. A number of datum lines were marked out on the abutments to tie in with this drawing, as any errors in the work would prove very troublesome when the unit eventually arrived to do the bridging. Supervision of the contractor's work was arranged with the Commander, Amphibious Warfare Experimental Establishment, who was engaged full time as the co-ordinator of R.E. work in the area, and from him daily reports were received by telephone at Penhale. It is only fair to record that the work was done with an exactitude we had not dared to expect.

In addition the supply and transport of the bridging material were arranged with a representative of C.E. Southern Command. It was to come from Weyhill, some 160 miles, and was required to be loaded ready to move at twenty-four hours notice when the completion of the contractors work could be foreseen. Arrangements were also made with the Chief Constable of Devon, who was personally in charge of police arrangements in the area, for the closing of the Lynton road when bridging was due to start. The whole party then returned to Penhale Camp to continue their annual training programme.

During the next two days the officer i/c bridge worked out two complete launching plans, the one based on launching rollers placed in their normal relation to the base-plates, and the second on the assumption that the contractor would have had time to provide the more forward supports. With the former method, conditions were going to be tight but practicable. The short run-back from the bank-seat involved a maximum counterweight of twelve tons, but this could be reduced to five tons in the more favourable case. For both plans detailed calculations were made of the exact counterweight necessary for each bay of bridge added to the tail, and the loads on the rollers were checked. In the event, it proved possible to use the forward launching rollers and this avoided a lot of work humping counterweights as each bay was added. Even as it was, this was no light task.

During this period communications were arranged. A telephone link was established between the harbour area, the marshalling area and the bridge site to supplement the unit radio net. A radio link back to Regiment proved impossible as no equipment powerful enough was forthcoming. Reports were sent over the civilian telephone, though this was already overloaded.

By Wednesday morning, 20th August, Commandant A.W.X.E. reported that the contractor estimated he would be ready by 1700 hrs. on Friday, and in his opinion this estimate was a reliable one. It was decided to go ahead on this basis, and O.C. 316 Field Squadron issued his orders. C.E. Southern Command was advised of the R.V. for the bridging material at a lorry park in Barnstaple at 1400 hrs. on Friday, and he confirmed that it would be brought by a self-supporting platoon of a Transport Company, R.A.S.C. A squadron officer was sent to Southern Command with instructions to check that all parts were loaded and to number the lorries of the convoy, making lists of the contents of each vehicle. These were loaded to the standard Bailey bridge loadings. He was to pay particular attention to (*a*) the jacks being in good condition, (*b*) no paint in the pin holes of the panels, and (*c*) the swivel couplings of the swaybraces were not rusted. He himself was to report to the bridge site ahead of the main convoy, bringing one grillage lorry and one accessory lorry. The squadron advanced party left camp on Thursday afternoon and started work on site on Friday morning. The main body left at 0930 hrs. on Friday, taking field cooking equipment and two days rations in tinned equivalents. They arrived in their harbour area at 1630 hrs. and had a hot meal. The bridging convoy left on Thursday, staged overnight at Taunton, and kept its rendezvous on time. It was in harbour by 1600 hrs. on Friday. The contractor was as good as his word and by shortly after 1800 hrs. the site was ready for bridging. He had done his job remarkably intelligently, concentrating on the necessary work and leaving till later such jobs as could be done after the bridge was in position.

At 1900 hrs. the road was closed by the police, and at 1915 hrs. the first lorries were unloaded. Building began at 1930 hrs. and continued without a break until the bridge was completed at 0315 hrs. on the Saturday morning. Much of the work was done after dark, but a lighting set was in operation with clusters of high-powered lamps, specially obtained, fixed to neighbouring trees and telephone poles. The bridge was handed over to a representative of the County Surveyor, who allowed a little emergency traffic to cross at about 0900 hrs. At the County Surveyor's request the deck of the far end of the bridge had been made 9 in. above the existing road level, as he wished to take out a dip in the road just at the run-on to the bridge. This "gap" was filled up by the contractor using tar macadam during the morning of Saturday and the bridge was finally opened to traffic at 1200 hrs. The squadron left for camp after breakfast, except for a small rear party who back-loaded surplus stores and generally tidied up the work. The whole unit was clear of the site by 1300 hrs. and back at Penhale by nightfall.

Thus finished an operation which, in the Territorial Army at any rate, occurs once in a lifetime. A job closely fitting the active service model, with the added spur of knowing that it was urgently and vitally wanted by our fellow countrymen in trouble. This article has dwelt more on the planning than the construction, as it was an example to everyone taking part of the value of careful attention to detail throughout the planning stages. In spite of the mixed types of troops forming the squadron, and the complete lack of training on the Bailey bridge of many of them, the actual work went without a hitch.

The enthusiasm among the troops was, of course, immense, and at the slightest excuse the rest of the regiment would have been there too. It was a pity from their point of view that we were ruled out from taking on a number of other tasks in the area by the fact that they could not be completed in the two weeks we had available before returning to our civilian jobs.

HISTORY AND TRADITIONS OF THE CORPS OF ENGINEERS, U.S. ARMY

MOTTO "ESSAYONS"

By Lieut.-Colonel P. Drake-Wilkes, R.E.

NECESSITY may or may not be the Mother of Invention but it is usually the Mother of all Military Engineers. The birth of the United States Corps of Engineers was no exception. When the Colonies took their wrongs to the ultimate court of war and called on George Washington to take supreme command of the hastily formed armies they gained not only a great Commander but one who, by his foresight, laid the foundation of a Corps which has been described as "the oldest and steadiest branch of the Military Establishment of the United States."

The proud boast of the United States Engineers is that Washington was the first American Military Engineer and no one who has studied the career of this remarkable man will deny their claim. Long before the outbreak of war with England, Washington, who had been trained as an engineer, had surveyed large parts of the settled colonies and had accompanied General Braddock on his expedition against the French and Indians. In fact it was he who was responsible for the cutting of the road the expedition followed.

When, therefore, he took command of the newly formed forces he was quick to appreciate the need for engineers if the war was to be brought to a successful conclusion. There were few engineers in the country, however, and those that were available were not particularly well qualified. Washington had a friend, however, Richard Gridley, a British Colonel of Engineers who was living in retirement in the Colonies. On 16th June, 1775, the day before the Battle of Bunker Hill, Colonel Gridley at the age of 64 was appointed Chief Engineer, with his cousin Jonathan Baldwin as assistant. From this date the Corps of U.S. Engineers count their foundation and whatever the reasons for his appointment, it must be with a certain amount of pride that we find a former British engineer officer selected as the first Chief Engineer of the United States Army.

No portrait of Colonel Gridley has survived the years and little has been published of his work but there is no doubt that during his life he enjoyed an outstanding reputation in two Continents as a military engineer.

On the day after his appointment the new Chief Engineer was at Bunker Hill enthusiastically tracing the fortifications, helping to erect the ramparts and fighting in the battle until a wound caused him to leave the field. He was forced to retire for the second time in 1776 as a result of this wound, but it must have been some compensation for him to learn that his accomplishment in fortifying Dorchester Heights had caused Lord Howe to exclaim, that the Americans had done more in a night than his "whole army would have done in a month."

It is interesting to note that his assistant, Jonathan Baldwin, continued in the Army and took part in many campaigns of the Revolution. He was promoted to Lieutenant-Colonel and was the Engineer Adviser at the siege of Quebec. He was at Saratoga when Burgoyne surrendered, caught smallpox and tried to resign from the Army. His reasons for resignation could have been written by anyone, anywhere, in any war, for in addition to not receiving his pay and having his clothes stolen, he wrote: "I am highly tired of this retreating, ragged, starved, lousy, peevish, pocky Army, in this unhealthy country." He was naturally not permitted to resign for such inadequate reasons and continued in the Service being eventually promoted to Colonel.

As the war progressed the necessity for more and more skilled engineers became increasingly apparent and Washington was forced into recruiting several French officers who were commissioned into the American service. The most prominent of these was Du Portail who came to command the Corps of Engineers and was promoted to Major-General at the end of the Revolutionary war. The influence of a foreign element in the American Army had important effects in the later history of the Corps and to a certain extent the whole army. Even to-day in General Staff procedure, and in other small details, the French influence can be detected.

With the commissioning of more officers, a plan was prepared for the proper establishment of a Corps of Engineers, and in 1778 the needs of the Service were partially met when Congress authorized three companies of Sappers and Miners. These companies were the first organized bodies of Engineer troops, but it was not until 11th March, 1779, that a resolution constituting a Corps of Engineers was finally passed in Congress and their responsibilities defined as:—

"To understand the fabrication of field works . . . to instruct fatigue parties to do their duty with celerity and exactness, to repair injuries done to the works by the enemy's fire and to prosecute works in the face of it. The commissioned officers to be skilled in mathematics ; the N.C.Os. to write a good hand."

A concise definition of the duties of Engineers which can hardly be bettered after nearly 200 years.

The Sappers and Miners were no sooner formed when, like all military engineers throughout the world, they proceeded to participate in every action of the war, serving with efficiency and distinction until the conclusion of hostilities. The records of the Continental army are most incomplete and of the men who fought in the new Corps, not very much is known; two names, however, survive: Moses Cleavland, who became the founder of Cleveland, Ohio, and Pierre Charles L'Enfant, who laid out the City of Washington.

In 1783, the Corps of Engineers was mustered out of the Service. They were not alone in this fate, however, for Congress in the manner of democracies, both before and since, could see no reason for maintaining an army after a conclusive victory and reduced its entire strength to seventy men. Fifty-five soldiers were stationed at West Point near New York, the remainder being sent to Pittsburgh to guard stores. So it was that for a few months in the summer of 1784 one, John Doughty, commanded the whole of the American Army with probably the lowest rank ever held by a Commander-in-Chief, that of Major. In spite of many appeals by Washington, this state of affairs continued for ten years.

Troubles with the Indians were constantly flaring up, however, and several expeditions were sent to protect the settlers in the West. Each expedition was decisively beaten and with each defeat Congress authorized another regiment for the Army. Finally, in 1794, a small nucleus of a regular army had been built up ; but by that time the new country was facing more serious threats. France, the ally of earlier days, was threatening war and with a long unprotected coastline, Congress was forced to act. A decision was made to fortify the coast and once again it was found that suitably trained and qualified engineers did not exist in the Army. Fortunately some of the French Engineers who had served in the War of Independence were still in America, and a number of these were reappointed and entered upon their new duties without delay. At the same time the necessity for a small Corps of " well disciplined and well informed Artillerists and Engineers," which had been recommended in 1789, was at last appreciated by Congress and authority was given for the raising of four battalions, each for a term of three years. The Commander of these battalions was a Frenchman, Rochefontaine, one of his Majors being the late Commander-in-Chief of the American Army, John Doughty.

The main body of Engineers and Gunners was stationed at West Point, where at the same time a Military School was organized.

It would be impossible in this short paper to follow the rise of the Military Academy at West Point through the 150 years of its existence. Its history, however, is inextricably mixed with that of the Engineers who founded it and staffed it and taught there for 65 years. Not until 1866, when it passed to the Army at large, did

Engineer Superintendency end, and of the Corps stewardship it was written that " the present efficiency, everywhere acknowledged, was given to it during the sixty years' control by the Corps of Engineers."

The combination of Sappers and Gunners was not a success, the duties did not mix well and neither did the officers who, at that time, consisted of representatives of practically every European nation. The system continued, however, for eight more years during which a second regiment was raised in which a Major Jonathan Williams started his rise to prominence.

Jonathan Williams had had no previous military experience prior to his commissioning as a major in 1798, but he was one of the acknowledged scientific leaders of the country. In a very short time he was assigned the duties of Superintendent of the new Military Academy as well as being appointed Chief of Engineers. It was in his latter capacity that he designed the fortifications of New York harbour, which so satisfied the citizens that they made him a Freeman of the City.

He was a brilliant scientist, but frequently found himself in difficulties with the rest of the Army. He resigned twice, on each occasion as a result of his attempts to obtain the right of Engineer officers to command outside their own arm. Though he was overruled then, his efforts bore fruit in future years for to-day the Engineers are the only Service whose officers can and do command line units.

In 1802, Colonel Williams was made Chief Engineer and this event marked the beginning of the present Corps, for Congress finally approved the establishment of a separate Corps of Engineers on 16th March of that year. The numbers authorized were very small, being only one colonel, two lieutenant-colonels, two majors and sixteen junior officers, with one sergeant and eighteen enlisted men added a year later.

By 1812, when war was once more declared against Great Britain, the Corps had increased to 22 officers and 113 enlisted men, most of whom served in all the campaigns from Hull's ignominious failure at Detroit in 1812 to Jackson's final victory in 1815.

The land operations of the war added little lustre to the arms of either of the combatant nations, but the Engineer officers gained distinction wherever distinction was to be gained. Out of seventeen officers who saw action, four were killed or died and ten were breveted, three being breveted twice. At that time the brevet was awarded for bravery and efficiency in action and was both a form of temporary promotion and a decoration. It will be seen, therefore, that the Engineers fully lived up to the high traditions they had earlier established.

The war of 1812 brought into being a new arm of the Service, the

Corps of Topographical Engineers. The need for mapping and surveying the vast areas of America had become increasingly important as the population increased and moved westward and the war had disclosed the utter inadequacy of what maps were available. Congress accordingly authorized, as part of the General Staff, eight majors and eight captains to be known as topographical engineers. With the coming of peace all but two of the majors were mustered out of the Service. A year later, however, five topographical officers were provided for each army division and in 1818 these officers were removed from General Staff status and placed under command of the Chief Engineer.

The growth of "private armies" was not unknown, however, even in those days and soon the Topographical Engineers had established themselves as a separate bureau and finally in 1838 as a separate Corps. They were assisted in their efforts by the demands of the people for internal improvements, roads, canals, trails, everything that would assist in the development of the huge continent to which they were now the heirs. The Topographical Engineers were the obvious choice. The Corps of Engineers continued to handle fortifications along the coast and the new Corps became responsible for explorations and internal improvements.

The men who staffed the Topographical Engineers penetrated to all parts of the continent and many became famous. Stephen Long explored Colorado and designed a bridge truss which was used very considerably in railway construction. George Whistler was an equally noted topographic engineer as well as being the father of James Whistler the famous painter. John Fremont achieved great prominence both in winning California for the United States and becoming one of the most conspicuously unsuccessful generals of the Civil War.

For half a century the Topographical Engineers continued as a separate Corps, being in charge of a vast number of projects, both civil and military, which contributed in no small extent to the enormous expansion of the United States during that period. In 1863, their major work completed, they were consolidated with the Corps of Engineers and lost their separate identity for the second and last time.

It is necessary, however, to return to 1816 when, following the close of the war with Great Britain, the army as usual was reduced and a peace strength fixed at 10,000 officers and men. All the engineer enlisted men were either discharged or transferred to the Artillery, but the officer cadre of the Corps of Engineers was retained, chiefly because the coast fortifications remained a continual source of anxiety, particularly on the Atlantic and the Gulf Coast. In spite, however, of the excellent services which the Engineers had rendered in the recent war the old idea still persisted that good engineers must necessarily be foreign and Simon Bernard, a general in the late Napoleonic army, was invited to America and appointed Assistant Chief Engineer with the rank and pay of a brigadier-general.

Bernard was an expert on fortifications, but his arrival was bitterly disputed by the senior officers of the Corps, many of whom resigned in protest. Bernard, however, persevered in his appointment and formed a Board of Engineers which was active for forty years. The board, among its other activities supervised the work of the Topographical Engineers and during its life the first survey of the Mississippi River was made, canals were dug, roads laid out and finally in 1829 it supervised the construction of the first railroads. General Bernard finally retired in 1830, having previously had a heated difference of opinion with the Commanding General of the Army of the South, one Andrew Jackson. When Jackson was elected President, Bernard having no delusions as to his future promptly went on six months leave and posted his resignation from France.

From 1821 when the company of Bombardiers, Sappers and Miners was disbanded, frequent requests were made by the Chief of Engineers for at least one company of engineer soldiers to be included in the peace establishment. There was, however, active opposition to maintaining any permanent military forces in peace-time and his efforts were of no avail. Then in 1846 came the battle of Palo Alto and the war with Mexico. On 15th May of that year Congress authorized a company of engineer soldiers and Company " A " came into existence. From that day Company " A " has remained continuously in active service. Of its first officers, 2nd Lieutenant George B. McClellan rose, in the Civil War, to command the Union Armies, and the other two subalterns both became General officers.

At the end of September the company had received its basic training and was ordered into Mexico, where it took part in the campaign against Vera Cruz. It was in this action that the first amphibious landing was made by American forces and one or two important differences can be discerned between that landing and the more recent ones in the late war. At Vera Cruz, the Engineer Company marched ashore in broad daylight with flags flying and bands playing and such was the display of martial might that the Mexican Army offered very little serious opposition and finally Vera Cruz capitulated.

Nineteen officers of the Corps of Engineers served with the Armies in Mexico, with Brigadier-General Totten as their Chief Engineer. It was in this war that the Engineers found their greatest opportunities both from the circumstances of the campaign and the character of the Commander-in-Chief, General Scott. Utilizing his Engineers to the utmost he found among them such men as Lee, Johnston, Stevens, Beauregard and others whose names in later years, were to become world famous. Ten officers received brevets, three, of which Lee was one, being breveted three times.

After the war the Engineers were kept busily employed in renovating and constructing fortifications, laying out railway surveys, building roads and bridges on the Pacific Coast, erecting lighthouses and gradually increasing their strength as their work became better known and appreciated. Then in 1861 came the tremendous struggle between the states that was to engulf most of the continent of America and send its repercussions round the world.

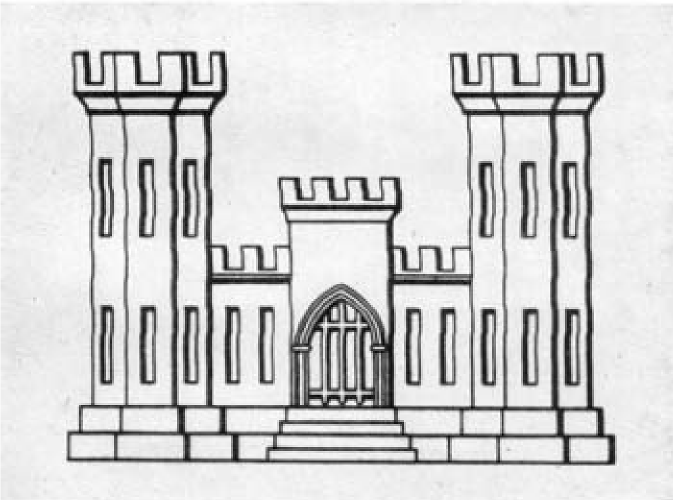
So much has been written of the Civil War that little need be said here except to emphasize its unique position in the history of warfare. It was the last of the old style wars with animal transportation, smooth-bore muskets, primitive supply and medical services; yet as the war progressed railways were used, pontoon trains were organized, steamboats, armoured ships, balloons, photography and rifled weapons all came to play their part and from the heat of this conflict the concepts of modern warfare were born.

The outbreak of the Civil War found the Union Army with two organizations of Engineers of a total strength of seventy-nine officers and one company of a hundred men. These numbers were shortly increased by twenty-four officers and four companies of Engineers, one of which was a Topographical Company. The original Company "A" was withdrawn from West Point and sent to Washington, proceeding later to New York to put the city fortifications in a state of defence. It returned to Washington in September of 1861, where Companies "B" and "C" were assembling, and joined the battalion of Engineer Troops, a hastily formed provisional headquarter organization which, nevertheless, continued to exist throughout the war.

During the winter the Engineers were engaged upon the construction of the capital's defences and in training in the use of pontoon equipment, with which they were to be so largely concerned later in the war. In March, 1862, the battalion was formally placed in support of the Army of the Potomac with whom, in the normal Engineer manner, it took part in every notable action until the end of the war. Its duties were the usual engineering ones of bridge building, road making, sapping, mining, and fighting as infantry as the occasion demanded. Its chief accomplishment was, however, the construction of railroad bridges which in their size, capacity and speed of erection were regarded, on first being reported, as fabulous by the military engineers of Europe.

The bridge across Potomac Creek constructed by General Haupt, an Engineer officer, was 400 ft. long and 80 ft. high, being built entirely from local timber, of which 2 million feet were used. The

No portrait of Richard Gridley is known to exist. The above is an enlarged facsimile of his signature and his famous map of the Harbour of Louisburg.



The Turreted Castle, Official Insignia of the U.S. Corps of Engineers.

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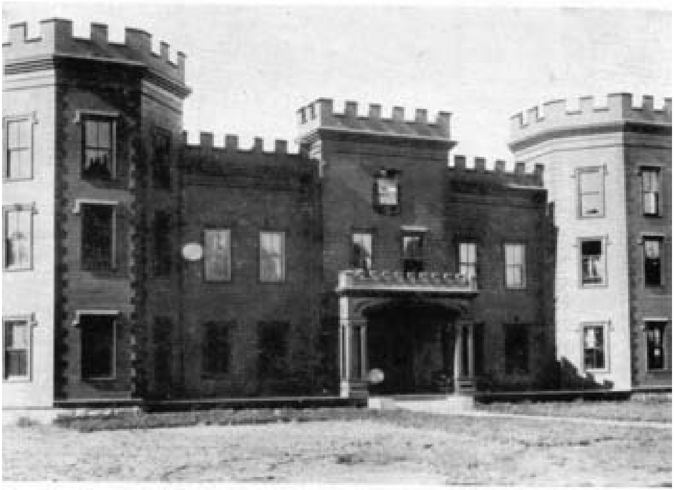
Abbot Hall. The Headquarters of The Engineer School, Fort Belvoir, Virginia.



The Officers' Mess, Willets Point, New York. 1902.

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bents were four stories high and this remarkable erection was completed in nine days, during which the bulk of the timber was cut and hauled. Of even greater size was the bridge across the Chattahoochee River near Atlanta, which was 780 ft. long, 90 ft. high and was constructed in four and a half days.

These bridging exploits resulted in General Haupt being invited to England in 1868 to address the British Association for the Advancement of Science on how such structures were erected, and at the conclusion of his lecture a banquet in his honour was given by the officers of the Corps of Royal Engineers.

With Lee's surrender of the Confederate Army on 9th April, 1865, the Battalion of Engineer Troops was given its final task; being sent ahead of the Army of the Potomac to repair the roads and bridges in preparation for the Army's triumphal march to Washington.

The services rendered by the Engineers in the field, however, though arduous and performed with efficiency and gallantry, formed only a minor part of the duties accomplished by the Corps of Engineers. The requirements of the Engineer Battalion absorbed only a small part of the commissioned strength of the Corps and the greater proportion of Engineer officers served on the staff or in command of troops of the line with the greatest distinction. Of approximately one hundred general officers on both sides who served during the war, twenty-nine were or had been Engineer officers.

It is obvious to a student of this period that neither the Union nor the Confederate Forces had an adequate engineer organization. In the Union armies Engineer Regiments, composed of volunteers, were added from time to time to assist the regular establishment but the numbers and skills fluctuated and in many cases pioneers from the line regiments had to be impressed for duty. The Confederate forces had no authorized Engineer Troops until 1864, when three regiments were formed, although by the end of the war they had increased the number of their companies to thirty-five.

The Civil War and the period immediately succeeding, brought certain changes which had a material effect on the Corps. Two have already been mentioned, the merging of the Topographical Engineers with the Corps of Engineers and the passing of Engineer control of the Military Academy to the Army at large. While these changes made for a stronger Engineer organization, nevertheless, they left the Corps without a school. A separate Engineer School was, therefore, established in 1866 at the previous Engineer garrison post at Willets Point, New York. For the first eighteen years of its history the Engineer School was not officially recognized, but under the inspired command of Colonel Henry L. Abbot, its first Commandant, and the then Chief of Engineers, Major-General Andrew

A. Humphreys, it progressed and developed on such sound lines that it was officially approved by the War Department in 1885, and redesignated the United States Engineer School. In 1905 it was renamed " The Engineer School," a title it has retained to the present day. In 1919 the School was moved to Fort Belvoir, Virginia, which is now the permanent home of the Corps.

For twenty-three years the United States enjoyed a period of peace until the outbreak of the Spanish-American War in 1898. The Corps of Engineers tightened its organization and with official approval formed its authorized five companies into a battalion, the troops of which were divided between the Engineer School and the Military Academy. The battalion, as well as performing normal engineer duties also engaged in such unusual tasks as suppressing illicit distilleries near the Brooklyn Navy Yard, riot duty in the railroad strike of 1877 and flood relief during the disastrous flood in Pennsylvania in 1889.

The Spanish-American war did not result in any great expansion of the Army. Two Engineer Companies were organized into a provisional battalion for service in Cuba and Company " A " went to Manila, being joined there later by Companies " B " and " E." Another amphibious landing was made, this time using pontoon boats, but the Engineers spent most of the war repairing roads, re-laying railway tracks and constructing bridges and ferries. That they were not used to their fullest capacity is shown by the fact that out of ninety-two General officers who served in the war only seven were originally Engineer officers.

In 1901 Congress increased the numbers of Engineer troops to three battalions and the old Battalion of Engineer Troops ceased to exist. Born of the difficulties confronting the Army in Mexico, expanded during the Civil War, revived and enlarged during the Spanish War its organization did not lend itself to further expansion, and its name, though not its traditions, disappeared from the roster of the Army. The newly formed battalions were stationed at Willets Point (School of Submarine Mining), Washington Barracks, Leavenworth and Vancouver Barracks, with periodic tours of duty in the Phillipine Islands, Panama, Hawaii and Cuba. At the same time Engineer officers carried out many other activities, their greatest feat being the supervision of the building of the Panama Canal after the project had been abandoned by France as impossible. The Engineers completed the construction of the Washington Monument, built most of the important government buildings in Washington, made roads in Alaska and were engaged in so many other public works that it would seem that there was hardly a new activity in the United States at that time in which the Corps was not involved.

In 1916, America entered World War I and the record of the

Engineers in that war was outstanding. Commencing with 256 officers and 2,200 men, by November, 1918, they had expanded to 10,000 officers and 285,000 men.

The immediate urgencies of the war made the Allies extremely anxious to put more Engineers on the ground and, therefore, some of the first troops to land in France with the American Expeditionery Force were units of the Corps of Engineers, the 11th Engineer Battalion being the first organization of the United States Army to participate in the fighting, being attached to the British Third Army in the Battle of Cambrai.

The formation of a separate American Army to the east of the British sector imposed an enormous logistic problem, as the U.S. lines of communications were forced to operate across the existing French supply system. This became almost entirely a matter for the Engineers. New ports were established, bases, railways, depots and camps were all constructed at the same time that Engineer units for the various divisions were being formed and trained.

In a little over a year the Corps had constructed eighty new shipping berths in fifteen ports, built twenty-three divisional areas and carried out over 300 major projects. When the war ended in 1918, 86,000 Engineers were actually engaged in combat duties with nearly 150,000 in support.

Reorganization of the Army followed the signing of the Armistice and the Engineers came in for their full share. The Chief of Engineers was authorized the rank of Major-General, but the total number of officers permitted in the peace establishment was reduced to 600. In 1936, 185 additional officers were added so that the Corps strength on 1st September, 1939, was 785.

No history of the Corps of Engineers, however short, would be complete without some mention of its civil duties, which commencing shortly after its formation have continued without interruption ever since. Some of the past projects of the Corps have already been mentioned, the completion of the Panama Canal, the numerous public buildings, the construction of the first national highways and the survey work in the early days of the new continent. To these duties was added in 1826 the responsibility for rivers and harbours and since that date all navigation improvements and most of the flood control projects undertaken by the Federal Government have become a Corps responsibility.

The total volume to date of river and harbour and flood control work, from the first expenditure in 1800 of 5,000 dollars on a survey of part of the Mississippi and Ohio Rivers, has exceeded £2,000 million and the successful accomplishment of the enormous Mississippi River project has established the Corps as the foremost authority on river engineering in the country.

World War II with its technical problems caused an even greater expansion than in previous wars. It is still too close for a critical appraisal to be made, but like the Royal Engineers the Corps rapidly acquired new duties. The development of aviation required the formation of a new type of organization, the Aviation Engineers, who did outstanding work not only at home, but in all the theatres of operations throughout the world. The responsibility for all military construction within the United States was given to the Corps in 1942, which increased the burdens and the size of their operations. The Alcan Highway linking the States with Alaska, was one of the many major accomplishments. Sixteen hundred miles long, with only four points of access for the delivery of equipment and supplies, it was built in extremes of temperature ranging from 40° below to 90°F. above. In every operation in every theatre, the Corps of Engineers were the advance units gaining wide recognition for their magnificent work in both technical and tactical operations.

At the end of the war the Corps numbered 700,000 men, of whom 500,000 were overseas, and of the many war leaders the Engineers can claim their full share. General Douglas McArthur, one of the most famous United States Generals, General Somervell, General Groves of atomic bomb fame, General Lucius Clay, the Military Governor of Germany, together with seven lieutenant-generals and thirty-one major-generals, all were late members of the Corps.

Throughout the 177 years of their eventful history representing a period of service spanning the entire history of the nation, the Corps of Engineers has amassed a proud record. The future is unfathomable, but in the words of the present Chief of Engineers, Lieutenant-General Lewis A. Pick, " The Corps faces forward with renewed confidence in the opportunities of the future...' The Past is Prologue '."

Insignia

" Essayons " Button

The confidence in which each successive government from the beginning of the Constitution, has had in the United States Corps of Engineers is reflected in the distinctive insignia that its officers are privileged to wear. The Engineer button is not only different from the one authorized for the rest of the Army but is unique in so far as it does not resemble that of the Engineer Service of any other Country.

The design consists of a representation of the bastion of a marine battery surrounded by water over which the rays of the rising sun are depicted, the whole surmounted by a soaring eagle bearing in its beak a streamer with the motto " Essayons."

The inspiration for the design is believed to have originated in the defence works of New York Harbour, constructed by Colonel Jonathan Williams. In 1812, Colonel Williams introduced a form of defence, not known in America at that time. This was the casemated embrasure which consisted of a thick head-cover for the guns, which protected both guns and gunners from enemy fire. The gateway of Castle Williams, as the main bastion was named, had a plain stone arch with a stone eagle as a decoration placed over the centre. It is therefore, easy to discover how the principal elements typified in the button came into existence.

The motto "Essayons," the literal translation of which is "Let us strive," was inspired by the close association French Engineer officers had with the newly formed Corps in the days of the American Revolution.

In 1902 "Regulation" buttons were officially ordered for the whole of the Army, but the Corps of Engineers was allowed to retain its own distinctive button.

Collar Device

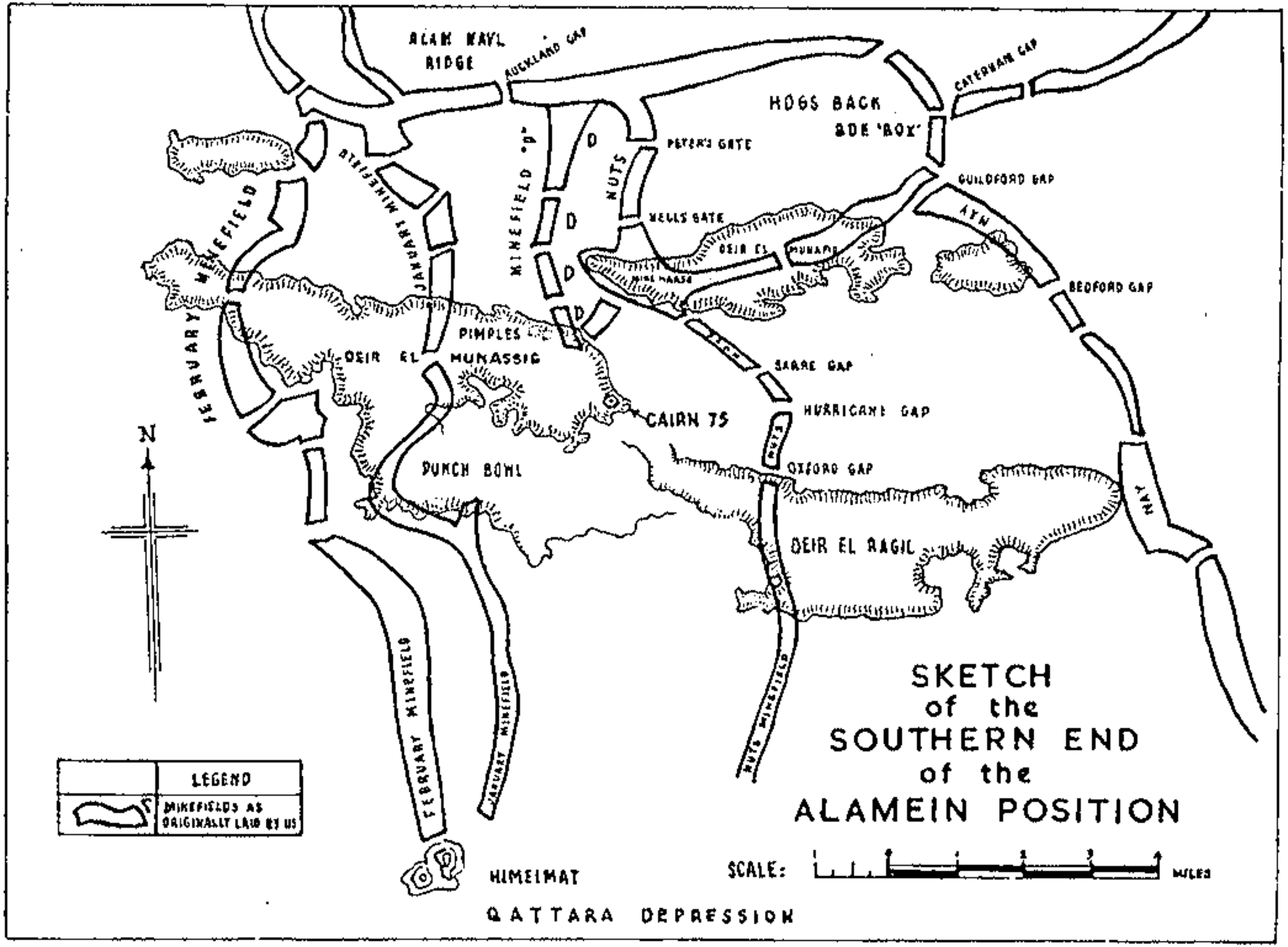
General James Totton one of the great Chiefs of Engineers accepted the turreted castle as the official insignia of the Corps in 1839.

Prior to that date a star surrounded by a laurel and palm leaf had served as the collar ornament of the Engineers. This device was not, however, confined exclusively to the Corps, other branches of the Army wore it on various parts of their person, general officers having it embroidered on the skirts of their jackets. It was, therefore, neither distinctive nor symbolic and its passing was unmourned.

The present badge represents a castle in its most conventional form and is believed to have been designed by a French officer stationed at West Point and had for its inspiration one of the gates of Verdun. The original gate has survived the last two wars and is still standing.

Although primarily designed for the Engineers its first appearance, in September, 1839, was on the cap-plates of the Cadets of the Military Academy at West Point. It was, however, officially prescribed for the Corps later in the same year. At that time it was worn on the epaulette and belt plate and moved up and down the uniform during the ensuing years, appearing at times on the shoulder, on the hat and finally on the saddle cloth.

With the new clothing regulations of 1902, it disappeared from all these places, and was officially promoted to its present position on the collar. In 1921 its colour was changed from silver to gold.



SKETCH of the SOUTHERN END of the ALAMEIN POSITION
ALAM NAYL RIDGE
AUCKLAND GAP
HOGS BACK
BDE 'BOX'
CATERHAM GAP
GUILDFORD GAP
PETER'S GATE
NELLS GATE
NUTS
MINEFIELD "D"
D
DEIR EL MUNASSIB
BEDFORD GAP
SARRE GAP
HURRICANE GAP
OXFORD GAP
CAIRN 75
PIMPLES
DEIR EL MUNASSIG
PUNCH BOWL
DEIR EL RAGIL
NAY
FEBRUARY MINEFIELD
JANUARY MINEFIELD
NUTS MINEFIELD
N
LEGEND
MINEFIELDS AS ORIGINALLY LAID BY US
HIMEIMAT
SCALE:
MILES
QATTARA DEPRESSION

TIN TRIANGLES

By Colonel J. M. Lambert, O.B.E.

IT is now ten years since the " turn of the war," and the earlier war years seem, in retrospect, to have receded almost to " 1942 and all that." But in the study of mine warfare it is to that period we must turn ; it provides probably the best prospectus we have of the two main categories of mine warfare—defensive and delaying—and the only occasion (apart possibly from the Russian campaign) of the large-scale use of mines in position warfare.

Defensive mining on a very large scale was resorted to by both sides in the Alamein position during the summer and autumn of 1942 ; whilst the subsequent withdrawal of the enemy to Tunis provides a classic example of the use of mines and traps as a delaying expedient.

The following rather random reminiscences deal with the subject mainly from a psychological angle.

Mine warfare is an unpleasant business. It is foreign to our character to set traps cold-bloodedly, or to kill a man a fortnight in arrears so to speak, when you yourself are well out of harm's way ; and most British soldiers, who have experienced it, will own to a rooted dislike of mine-warfare—in principle and in practice.

There is, too, something faintly derogatory about becoming a casualty from a mine ; as a weapon of war it lacks the distinction of shell or bullet. If one has got to lose a foot (or one's life) it seems more respectable somehow for it to be done by a shell rather than a mine. After all, anyone might step on a " butterfly " mine in the backyard of the N.A.A.F.I. Club at the base ! And the same applies to vehicles ; " stopped by an 88 " is much more satisfactory than " ran on to a mine." I have seen a group of soldiers roar with laughter at a vehicle going up on a mine ; immediately after the explosion there was a sudden silence, but when the dust cleared away and the lopsided immobility of the vehicle told its tale the men were highly tickled : the same sense of the ridiculous perhaps, as is aroused by an important-looking Rolls-Royce with a puncture. It seems possible that casualties from mines were underestimated, for when there was a doubt in the matter (and in battle there is often a very real doubt) the shell may sometimes have got some undeserved credits.

But our dislike of mines is by no means unqualified ; in the days when we were occupying what were then called " boxes " in the Libyan Desert, and expecting attack by Rommel's tanks, mines were at a premium. They became almost what Ordnance describe as a "desirable store." Units and formations in the battle area surrounded themselves with minefields, in which were a few carefully guarded "gates." These minefields were conspicuously marked by perimeter fences consisting of one or two strands of barbed wire on which were hung tin triangles. These latter dangled in the breeze and glinted in the sun; they could be seen afar off—which was just as well, for the enemy knew what they signified, and he didn't like our mines any more than we liked his. The breadth of the minefield between the "home" and "enemy" fences was usually some 300 yards in the case of a perimeter minefield; in the case of a "mine-marsh" it was often a matter of miles. Between the fences were, usually, some mines; but these ultimately became necessary more for our own peace of mind than to stop the enemy. For the latter purpose the wire fences and tin triangles sufficed. It is a strange reflection that possibly the most effective obstacle, evolved during the war was a single strand of barbed wire hung with tin triangles—provided that its significance was known. The original purpose of this type of fence was to prevent our own vehicles from straying into our minefields; but in fact, though unwittingly, we had imposed on the enemy a form of mine-consciousness which was scarcely realized at the time and seldom exploited. In the process we also had acquired a mine-consciousness of a different sort.

The "mine-threat" can be a potent and subtle weapon on occasions, as shown by the following incident. The sketch map shows part of the minefield system at the southern end of the Alamein position in September, 1942. All the minefields shown had been laid by us, but the enemy had captured "February" and "January" and had made the latter his forward minefield—protecting his F.D.Ls.

On our side, "The Hog's Back" was our most southerly brigade "box," its forward minefield being "Nuts." This minefield was under enemy observation and its gaps "registered"; any movement through them by day brought an immediate enemy reaction, but by night infantry patrols from the "Hog's Back" used to go as far as the home fence of Minefield "D." The further fence of Minefield "D" was enemy property and his patrols came up to it nightly; there were occasional inter-patrol scraps across the intervening 300 yds.

Now in Minefield "D" there were no mines. It was fully provided with triangled fences, and gaps with the regulation red and white gap markers; and someone had thoughtfully left some empty mine crates and detonator boxes lying about. But not a single mine had been laid in it by us; either time or the supply of mines had run out.

One night the enemy advanced his F.D.Ls. from behind the

"January" minefield to immediately behind Minefield "D." Whereupon the following questions arose :—

(*a*) Had the enemy already discovered that Minefield "D" had no mines in it?

(*b*) If so, had he put mines into it or was he keeping it as a dummy for his own ends—i.e., further attack?

(*c*) If he had not discovered it was a dummy how long would it be before he did so?

(*d*) Should mining activity be heard or observed could it be taken at its face value? Might not the enemy also make a pretence of laying mines, and perpetrate a double bluff?

The battle of Alamein was at this time being planned and the state of Minefield "D" became a matter of importance—not only in view of a possible further advance by the enemy, but of our own projected assault through it. A Sapper reconnaissance was ordered.

The comprehensive reconnaissance of an enemy or enemy-dominated minefield, even though it be a visible one, is never easy—and in a case of this sort the difficulties are considerable. It is important that they be appreciated as having a bearing on our own technique of defensive mining and the design and densities of our minefields.

What was asked for in this case was an answer to the question "Is Minefield 'D' still a dummy or has the enemy made it a real minefield?" After a certain amount of sterile argument about the meaning of the term "minefield" it was decided that, if *one* mine could be found in Minefield "D" it would be accepted as evidence that it was now in fact a minefield; but negative evidence would not be regarded as conclusive. For it is easy to spend a long time in the dark searching for mines in a wide minefield without finding any—all the more so if the mines in it are located near the enemy fence. Further, even if it can be established that there are no mines there to-night, it is no guarantee that there will be none to-morrow.

On three successive nights R.E. reconnaissance parties or individuals managed to get unobserved into Minefield "D." On each night the report was the same—"No mines found in the minefield, but the gaps are now heavily mined with Tellermines."

It looked as if the tin triangles had done their work—and in fact they had. The bluff had held and all that the enemy had done was to mine the marked gaps—thus producing an "Alice through the Looking Glass" sort of minefield in which the gaps were minefield and the minefield was gaps.

The sequel was unhappy, however, for in our subsequent attack through Minefield "D," the leading carriers of an assaulting battalion made straight for the marked gaps and were blown up. This may have been due to a miscarriage of orders—or was it a further example of the hypnotic effect of the tin triangle?

But the mineless minefield, however efficacious and economical in theory was seldom used in practice. If one is going to sit behind a minefield it is agreeable to know that there are some mines in it—and the more the better. This very understandable feeling led to demands for more and ever more mines. They were ordered up by the ten thousand, and the number used in the defensive position of an infantry division was of the order of a hundred thousand. The supply never failed—a feat of engineer organization and initiative at the base that was perhaps not sufficiently appreciated. The total number of mines laid by us (few if any of which were destined to bag an enemy tank) must have been not far short of a million in the thirty-mile length of the Alamein position.

One morning during that summer, an Infantry Brigade Commander asked the C.R.E. of his division to come over and see him on an urgent matter. The C.R.E. climbed into his jeep and drove over to the brigade " box." He entered the latter through one of the " gates " in its perimeter minefield and, leaving his jeep at the customary polite distance from Brigade H.Q., descended into the Commander's dug-out. The Brigadier was looking troubled. " Charlie Robert Edward " he started impressively " are there any mines in the minefields round this box ? " The C.R.E. was a trifle startled. " There certainly are," he replied, " we didn't actually lay them ; but a few weeks ago, when you wanted that extra " gate " made, my sappers made the gap and lifted quite a number of mines—they're about one per yard of front."

" Well," pursued the Brigadier, " are you certain that they're fused ? "

" I can't swear to it, sir, but I'm pretty sure I should have been told if the mines we lifted had been found unfused."

" Well then," said the Brigadier " how do you account for this ? It is my order that no one shall enter this " box " after dark without express permission of myself or of my brigade-major ; yet last night, whilst we were at dinner, in walked young Bobby Kiffen from G.H.Q.—cool as a cucumber. Said he'd driven down from Cairo in a jeep. I asked him how the devil he'd managed to get by the piquet at the gate and he said he hadn't seen any gate. D'you know what had happened, Charlie Robert Edward ? " and the Brigadier leaned forward in a rather menacing way, " he'd driven slap through your —— minefield ! "

The C.R.E. began to feel apprehensive. He could see all sorts of unpleasant repercussions looming ahead ; and he silently cursed Bobby Kiffen, whoever he was, into heaps.

" Well, sir," he said, feeling rather like a doctor making excuses for his medicine, " you know, it's quite possible for a lucky vehicle to get through these minefields ; the mathematics of it are rather complicated and I forget what the odds are ; but it isn't 100 per cent certainty that every vehicle will hit a mine. But," he added hopefully, "I wouldn't mind betting that if this bird drove out again through the minefield, he'd blow up all right."

"They must be *made* 100 per cent" retorted the Brigadier, thumping the table, "I'm going to talk to the Divisional Commander about this ; it's an important matter. My men's morale has been affected. Everyone in the brigade knows about this and the troops are saying that there are no mines in the minefield and that there's only a miserable strand of barbed wire with triangles on it to keep out the Boche tanks."

The C.R.E. had an idea that the barbed wire with its triangles was a more effective protection than the mines behind it and wished that the troops would spend more time keeping the fences intact and in good repair than worrying about the mines. However, he kept these views to himself and went off to his General to warn him of the breeze in the offing. The two of them got rather involved in mathematics and the calculation of odds, but as the Divisional Commander eventually said, it was a question not of odds but of confidence. He subsequently published an order that all perimeter minefields in the division would be gradually strengthened up to a maximum of three mines per yard of minefield. As each brigade "box" had a perimeter of at least five miles this was a pretty tall order for the Divisional Engineers and it was, in fact, nowhere near completed by the time the division moved out.

On another occasion camels were the cause of alarm and despondency. Stray camels were apt to congregate in minefields, which, being undisturbed, grew the best camel-thorn and similar desert vegetation. One minefield at the rear of a divisional "box" sheltered five or six families, totalling some thirty camels of all ages and sexes. They cavorted about, stampeded when shelled, trotted, galloped and rolled. The troops from their trenches near by eyed them expectantly and hopefully—for Thomas Atkins has no love of the "oont."

As the weeks passed and no tragedy marred the family life of these camels the troops began to wonder. Once again the word went round "No mines in the minefield"—and the C.R.E. was asked to have the camels removed. That officer, thinking that this was more a R.A.S.C. than an Engineer operation, told his adjutant to indent on Corps S.T. for "Bedouins—2, complete with camel bait." This demand duly went in on an ordinary indent form and resulted, surprisingly, in the arrival the following night, of two bedouins escorted by a sweating and embarrassed red-cap.

After spending the night in a slit trench and being subjected to some mild shelling, these two dignified gentlemen were taken to the minefield. The troops who had not seen a civilian for many months, were delighted. They watched breathlessly while the bedouins, following a Sapper with a mine detector, entered the minefield. They had no bait but made the appropriate noises for collecting camels. An hour later they went on their way rejoicing, followed by at least £1,000 worth of camels.

The cause of these camels' immunity was the subject of some speculation at the time. In this minefield (and at least one other in which camels habitually grazed) the mines were widely dispersed with a density of two mines per yard of minefield. All the mines were E.P. (Egyptian Pattern) Mk. II A. Tk. mines, buried 3 to 6 in. deep in soft sand. Samples lifted for inspection were in good order. They acted on the sheer pin principle, normally, at about 200 lb. dead load. The solution may possibly lie in the size and structure of the camel's foot, which spreads and cushions the load to a remarkable degree.

The demand for mines at this time (summer 1942) was tremendous; our infantry in particular had an almost insatiable appetite for them. The result could be seen in the Alamein position which consisted of five infantry division "boxes" each surrounded by tremendous perimeter minefields and with complicated systems of internal minefields surrounding brigade and battalion localities. Outside the divisional "boxes" were several lines of unwatched minefields many miles in length; tactical and spur minefields; nuisance minefields and immense mine-marshes. To complicate matters further there were also odd unmarked minefields left over from previous operations—some laid by ourselves, some by the enemy. One of the latter cropped up in the middle of a brigade "box" and only a few hundred yards from brigade H.Q. It was "discovered" by the C.R.A. who drove on to it one morning in his carrier. The brigade had been nursing it in its bosom, unknowingly, for over three weeks.

On the other side was the enemy minefield system. Most of this had been laid by us and subsequently captured by the enemy—which must have saved his sappers a lot of trouble. There was a certain amount of alteration to suit the new management—mainly by addition of "S" mines and removal of the wire fences on our side. In this latter lay the main difference between the enemy's technique and our own. He concealed his minefields and used mines as weapons. We made our minefields visible, and used them mainly as deterrents or delaying expedients; or at any rate we discovered that they acted as such.

Although the use of mines in mobile warfare has a different technique, its psychological aspect is no less important. An unrivalled opportunity for making the enemy mine-conscious is provided by the long withdrawal. It was exploited to the full by the Afrika Corps in its retreat from Alamein to Tunis. The mining and trapping tactics employed during that long retreat are well known and there is no gainsaying that they imposed a degree of mine-consciousness on the whole Eighth Army—and not only on the leading troops. Many miles behind the front a truck-load of reinforcements would blow up on a deep-laid Tellermine ; some men going for an afternoon walk from a transit camp would be killed by an overlooked " S " mine ; an E.N.S.A. concert party being driven home at night would stray into a minefield in the dark ; an uninitiated truck driver would step a few yards off the road to " brew up," and lose his life. Such occurrences were not uncommon many hundreds of miles behind the front. After a few weeks or months in that theatre every man was, like Agag, treading delicately ; and years later some of them found themselves, subconsciously, avoiding treading on the verge, even of a country lane in England.

It is remarkable that the momentum of our advance was maintained to the degree that it was—due undoubtedly to the already immensely high morale of our troops.

Such tactics in a long withdrawal undoubtedly pay a big dividend and, if employed intensively at the beginning of a withdrawal, may later continue to pay interest on a much smaller outlay. The aim must be not only short term and tactical, but long term and psychological. The symptoms of mine consciousness are—at the least, caution—at the most, loss of morale. Either is a desirable attribute in a pursuing enemy, and will result in his pursuit becoming a groping and cautious advance. He will be forced to adopt a slow and wearisome technique of searching for mines and traps—behind every bit of barbed wire, in and around every demolition and crater, in every pothole, culvert, diversion and harbour area. His road engineers will have to check every quarry, sand-pit and dump of road material ; his signallers will have to prod their way up to every telegraph pole ; his airmen to check every runway. He must be made to expect mines and traps of every description—including long delay-action mines and delayed major demolitions—either time-fused or actuated by his own vehicles.

If in this way mine-consciousness can be imposed early upon the enemy, then, in later stages of the campaign, the mine can, to a considerable extent, be replaced by the " mine-threat." This has obvious practical advantages, not only in economy of effort but in facilitating surprise counter-attack.

In static defence the value of enemy mine-consciousness is not so obvious, and the use of the mine-threat not so clear cut. Provided, however, that the enemy can be made to react to the visible minefield, the mine-threat can, in static defence, be usefully employed. It makes effective, as a deterrent, the low density minefield, which can be laid with great rapidity and economy. Surprise can be achieved by sudden assault through areas which the enemy supposes to be mined. By leaving large unmined gaps in our rearward minefields we retain freedom of movement for concentration and forming up prior to a major offensive—and without the possible loss of security caused by preparatory de-mining. Yet in the event of the enemy attacking, he will still be forced to stage a minefield-breaching operation—a difficult and often costly manœuvre, usually feasible only in darkness, and inevitably constricted to a narrow frontage.

The " Boffins " also can play a part in the imposition of mine consciousness on the enemy. The mine designer should always be able to keep his opponent guessing—thereby increasing the latter's caution and shaking his confidence in his mine-lifting and breaching techniques. By the nature of things the mine designer can quickly regain the initiative in this battle of wits, for although enemy counter measures may force the mine designer to modifications, yet he is under no compulsion to incorporate all the variations in any one design of mine. The detector-proof, blast-proof, flail-proof, roller-proof, prodder-proof mine may be feasible—but it is unnecessary. The use of a certain number of non-metallic mines was sufficient to destroy confidence in the mine detector ; the occasional use of the linked mine or the threat of it was sufficient to make the " Scorpion " obsolescent ; the use of even a small number of blast-proof mines makes suspect breaching devices relying on that principle. There are so many possible variations in mine design and so many different methods to exploit that the mine designer should always be able to have something " up his sleeve," with which he can regain the initiative should he lose it, and thus continue to impair the enemy's confidence.

Finally there is the consideration of what are generally referred to as " National Characteristics." Of what use would be tin triangles and the like against an enemy—if there be such a one—who ignores mines and accepts the casualties ? Here it will be relevant to consider the effects of mines as weapons—against infantry, tanks and vehicles respectively. For it is obviously in those circumstances, where the mine has proved most effective as a weapon, that the threat of it is likely to succeed ; if mines have proved sufficiently damaging, no enemy can afford to disregard the threat of them.

It is commonly accepted that anti-personnel mines will never stop fanatical or determined infantry ; and this is doubtless true of an infantry assault carried out in the heat of battle, when the mine is merely one hazard amongst many. A man under heavy shell-fire doesn't worry greatly about mines and may even be unaware that he is in a mined area ; an exploding mine may often be mistaken for a shell-burst. In such circumstances an anti-personnel minefield functions as an addition to, or substitute for, the defensive fire of guns and mortars. But the mine, being a one-shot weapon has only a limited stopping power against infantry ; it is by the fire of multi-shot weapons in the hands of the defenders that the assault, once launched, will be stopped. Used thus, as a form of close defence against infantry assault, the anti-personnel minefield, visible or concealed, is possibly in its least effective rôle.

The visible minefield may, however, succeed in canalizing attack into unmined or apparently unmined channels. The difficulty of discovering, with any degree of certainty, the strength of an observed minefield has already been mentioned.

In cold blood the case is different. Here the extensive use of anti-personnel mines can have a paralysing effect on the movement of infantry, though the nearest enemy troops may be many miles distant. As a deterrent to patrolling, probing or infiltration, or as an expedient to impede movement (as distinct from assault) by infantry on their feet, the anti-personnel mine proved itself in the last war to be a most formidable weapon. But large numbers of mines are required, and the time in which to lay them. Probably the most intensive use of the anti-personnel mine in this way was that made by the enemy at the approaches to the Agheila gap in January, 1943—notably at Mersa Brega. The circumstances were exceptional for nature had provided a narrow gap between marsh and sea, which allowed of mines being laid at densities unheard of before or since. Some of the minefields contained, in addition to anti-tank mines, belts of " S " mines six or seven rows deep, each mine being only about two feet from its neighbour. In some cases the sand had blown away exposing the three-pronged igniters, and the minefield looked like a field of some weird vegetable planted in neat and orderly rows. In other cases the mines were concealed by the vivid flowers of the wild ranunculus with which, at that season of the year, parts of the desert were ablaze. The casualties that would have resulted from a blind advance over such ground may be imagined, and it was not attempted. Even so our casualties from the " S " mines at Mersa Brega must have been heavy. It is unlikely that the enemy would have expended his mines in such a reckless and profligate way had he not realized that he was leaving Libya for good ; added to which there was the fact that a large supply of mines was at hand in his base dumps near Benghazi. Such a combination of circumstances may seldom recur, but is interesting as an example of what intensive anti-personnel mining can achieve. It held up our advance for several days when there was no enemy within forty miles ; the latter was enabled not only to pull out unscathed from his Agheila position, but to gain valuable time for digging in (and mining) at Buerat. This was a notable example of the use of the anti-personnel mine as a long-range weapon—a rôle in which it was far more effective than as a form of close defence ; and this was notably true of the

" S " mine, which will kill men in vehicles, except in closed-down tanks. Minefield breaching methods have improved since those days and there is always the possibility that some device will be evolved which will enable infantry to ignore the " foot-mine." Until then it seems improbable that a policy of ignoring anti-personnel mines could, except in the assault, be successfully imposed for long by any nation.

The anti-tank minefield on the other hand is more effective as a close defence against A.F.V. assault then in a long-range rôle. Again, it is ultimately the defenders' weapons that will destroy the offensive power of immobilized tanks by silencing their guns or inducing their crews to bail out ; but the stopping power of a good anti-tank minefield can be complete. It can not only immobilize the leading tanks but, in so doing, create an obstacle to those that follow—the more tanks the better the obstacle. For tanks unlike men cannot climb over the fallen bodies of their comrades. On three occasions (and there may have been others) during the summer of 1942 our tanks charged line abreast into unmarked enemy minefields ; on each occasion the attack was completely stopped and the crews had eventually to bail out. In one case eleven tanks, about thirty feet apart, had been stopped in a neat and regular echelon (the pattern of the minefield) each with a track broken. In no case could any tank recovery be effected until the ground on which they lay was captured by infantry. The enemy, if he had ever had any doubts about the efficiency of minefields, must have quickly lost them ; it is small wonder that he avoided trying conclusions with the tin triangle.

In an advance or pursuit, road vehicles are similarly susceptible. A well-placed mine can pick out a heavy vehicle in the middle of a column and convert it into an obstacle taking some hours to remove or by-pass. Or a mine may be used to actuate a major demolition such as a landslide.

Where " wheels and tracks " are concerned the mine discounts weight of numbers ; all is grist that comes to its mill—and the more the better. In this particular sphere it should be possible to impose mine-consciousness—or at least mine-wariness—on an enemy possessing even the most rugged national characteristics ; in any case his A.F.Vs., being less easily replaceable than men, will not be so lightly risked.

In circumstances where mines have proved particularly damaging, and so made the enemy mine-conscious, it seems possible, therefore, that the mine-threat could, on occasions and in small doses, be successfully used. On such occasions, and particularly when supplies of mines are a bit short, the Sapper may find good use for a truckful of old mine-crates or a pocketful of tin triangles.

THE DEVELOPMENT OF A M.E.X.E. MACHINE

By Colonel E. W. L. Whitehorn

SOLDIERS have a reputation for grumbling and I suppose that most of them at some time during their service have complained bitterly at the lack of suitable equipment, whether it be clothing, weapons, tools or transport.

I know that I, too, have done my share of complaining in the past, but having spent the last three years in trying to develop new plant for the Sappers I now realize the many difficulties that face those responsible for producing equipment, and it may interest the grumblers to know why their new machines are so slow in arriving.

I will take the case of a new piece of equipment which will enable the Sapper in the field to do some job more quickly and with fewer men than ever before, and to simplify matters I will call it Project "X."

Briefly, the War Office, having decided that "X" is necessary, asks the Ministry of Supply to develop it, and as "X" is a machine needed by the Corps it is probable that the Director of Royal Engineer Equipment (D.R.E.E.) will be given the task. D.R.E.E. has to decide whether the requirement can be met by offering a trade article, or by modifying a trade article, or if an entirely new machine will have to be designed. If the last alternative is the case, he must decide whether to give the task of design to a research and development establishment, or whether to place a development contract with an outside firm (a course he may also resort to in the case of modifying a trade article).

If a development contract is placed (I will assume that this is the course adopted in the case of "X") D.R.E.E. will almost invariably delegate the technical control of the project to the Military Engineering Experimental Establishment (M.E.X.E.), who will be responsible for giving technical advice and assistance to the firm throughout the design period and the period of construction of the pilot models, and for the technical tests of the pilot models when made. When M.E.X.E. are satisfied technically, acceptance trials are held, at which War Office are represented. After acceptance trials, either the original pilot models or some more prototypes specially ordered and built, will be sent for troop trials. These may result in further modifications, again probably involving work by M.E.X.E. and the development firm, after which D.R.E.E. can approve "X" for production. The production of "X" in quantity, as required by the War Office, is then arranged through D.R.E.E. production branches.

I can only attempt, in this article, to paint the picture of a plant project handled by development contract—only one aspect of M.E.X.E's. work. For a new bridge or a new mine, designed completely at M.E.X.E., the stories would be different in detail.

Many people are concerned with the development of a new item of equipment, and as an inevitable consequence much time has to be spent in consultation and discussion ; there are delays which arise during the period of design and manufacture of a pilot model ; a long period of testing is needed before teething troubles can be eliminated ; production drawings and a users handbook have to be prepared ; spare parts scales have to be agreed and finally manufacturing capacity has to be arranged for the production of the equipment in quantity.

As a result five years may well pass between the time the War Office decides that a new type of machine is necessary and the issue of the machine to the troops for general service.

In a short article it would be impossible to compress the whole story of the development of " X," so I will take a few of the difficulties which usually arise and will deal with each.

The Specification

When the War Office asks the Ministry of Supply to develop " X," it must, of course, give some idea of what is wanted from the new piece of equipment so that M.E.X.E. can take into account any ruling dimensions, any performance requirements and any tactical considerations, when the design of " X " is being worked out. The War Office therefore prepares a brief specification of " X " which it hands to the Ministry, and M.E.X.E. uses this to produce a detailed specification from which a manufacturer can make a pilot model. The War Office specification is often very brief indeed, giving but a bare idea of what is wanted, or it is studded with rigid and often conflicting requirements. For example, we may find that a machine such as " X " has to travel in an aircraft, wade ashore through feet of water, work at seemingly impossible climatic extremes, move on roads and cross country at high speeds, stand up to the worst handling that semi-skilled operators can give it on active service and yet have an output greater than that of any existing machine of the same type. Sometimes it is not even possible to go as far as this, for " X " may be only a vague idea at this early stage, and after discussions with the War Office and D.R.E.E., M.E.X.E. may have to carry out some experiments on which the War Office specification can be based.

The War Office is sometimes apt to ask for too high a standard in the specification, and the Ministry is equally apt to try to meet each requirement fully. The result is a machine which is often unnecessarily heavy, complicated and expensive and which works to an unnecessary close limit. For example, the specification for a tipping lorry may call for an angle of tip of, say, 60 deg. which will allow almost any known road-making material to be cleared from the body without assistance. In practice an angle of 45 deg. would be quite satisfactory with nearly every material, and if by chance some particular mixture would not quite clear itself a couple of sappers with shovels would easily remove the residue in a few minutes' work. A lorry body can be made to tip to 60 deg. but triple extension rams may be needed instead of double extension rams with resulting increase in cost, complication and possible increase of height of body from the ground.

It is the duty of both D.R.E.E. and M.E.X.E. to scrutinize the War Office specification closely, and if some of the features are considered likely to result in unnecessary bulk and expense, a conference should be called to decide whether any relaxation of the specification can be made. Further discussions are often necessary later on when difficulties arise over the design or construction of the pilot models of " X."

Now " X " may fall into one of several types. It may have a purely military use, it may be an entirely new piece of plant needed to make use of a new road-making technique, it may be a machine which has hitherto been manufactured only in America, or it may already exist as a commercial product. Assuming in this case that " X " is not a purely military requirement, M.E.X.E. prepares the detailed specification in the hope that a manufacturer will be able to sell a commercial version of " X " all over the world in large quantities. This has many obvious advantages for the Army—there will be stocks to requisition in an emergency, spare parts organizations will be in existence, trained operators will be available and a firm or firms will be all ready for large scale production for the Services. Furthermore, no manufacturer is keen to tool up a factory if the only demand on it in peace will be a few hundred of " X " for the Services.

The Manufacturer

Even if " X " exists as a well-tried commercial machine it nearly always fails to satisfy the War Office specification in some respects—usually it will not go in a glider, it cannot be towed at convoy speed or it is not robust enough for service conditions under climatic extremes. However, in such a case manufacturing capacity and experience exist and it is not very difficult to make suitable modifications : in several cases the manufacturer has come to realize that the military version is better than his commercial product and has adopted it in favour of the latter.

Where " X " is a machine which has never been made in this country, it is much more difficult to find a manufacturer willing to set aside design staff and manufacturing capacity to produce a new line which may or may not have a sale in two or three years time. The search for the manufacturer is a job for D.R.E.E., who may well have to work hard to persuade him to undertake the work : frequently the production side and I.E.M.E. as well as M.E.X.E. are able to help through previous personal contacts with firms.

Unfortunately, conditions are now more difficult for manufacturers than they have ever been, for not only are they struggling against shortages of materials and labour, but they are being asked to do something that they have never had to do before—export as much as possible and build for rearmament at the same time.

Where possible a manufacturer is chosen who will build the pilot models and when they have been fully tested will produce machines in quantity for the Services and for commercial sale. It is getting more and more difficult to find firms who are willing to do this, chiefly because of the shortage of design staff and because they are unwilling to upset their production lines which are fully occupied with export and rearmament orders.

A compromise has, therefore, to be adopted on occasions, and a design firm is found which has drawing office capacity and possibly an experimental workshop. The pilot models are designed and built here, and after they have been fully tested and give promise of having a useful commercial application, a firm is found which may be short of drawing office staff and unwilling to do experimental work but which is willing to produce the tested pilot model in quantity.

Manufacturers vary tremendously. Some are part of gigantic organizations, some have a few worn-out machine tools in a back yard ; one maker will set aside a whole team of draughtsmen and designers for Project " X," another will rough out some sketches on the back of an envelope and produce " X " from these. Some have wide experience in the design, use and sale of a particular machine, others will be making it for the first time, but all of them are helpful, enthusiastic and ready to take criticism and advice.

It may be asked why M.E.X.E. does not design and make the pilot models of " X " but the answer is quite simple—lack of design staff and workshop accommodation. The bridging and explosives wings have projects most of which are highly secret and which do not exist in commercial form so that they need all the available manufacturing capacity in the establishment. In the mechanical wing there are some sixty projects in hand varying from a small electrical gadget to an enormous earth-mover, and to provide a drawing office staff to deal with such a wide range of equipment would be practically impossible nowadays.

Construction

When the War Office has made it clear what is wanted, M.E.X.E. prepares a detailed specification and discusses it with a suitable manufacturer and D.R.E.E. arranges for a development contract to be placed for the construction of, say, three pilot models so that "X" can be said to have been fairly started, but a start is all that has been made for there is much work to be done before the first version of "X" is ready for trials.

If we assume that "X" is a piece of earth-moving equipment not hitherto made in Great Britain or an entirely new type of machine, the manufacturer will probably lean heavily on M.E.X.E. for advice and will ask for frequent consultations in the design stage to make sure that he is working on the right lines. Quite frequently he will ask for relaxation of some items of the specification or he may put forward improvements on the suggestions made by M.E.X.E. All this means constant liaison between M.E.X.E. and the firm concerned and D.R.E.E. and War Office will want to be represented at any meeting where questions of policy arise or a change in the specification is proposed.

Even if "X" is a standard commercial product which merely needs some modification to fit it for military use, there will have to be frequent discussions between M.E.X.E. and the maker because it is the policy to incorporate standard Army equipment whenever possible. Tyres, rims, brakes, instrument panels, lighting fittings, batteries, starters, dynamos and air filters have all been standardized for fighting vehicles and even if they were not of high quality, it would pay to fit them on Sapper equipment.

Once the firm begins to make progress with the drawings of "X" it starts to order materials and proprietary items and to subcontract such assemblies as it does not propose to manufacture itself. For instance, it may not have a foundry or adequate gear-cutting machines so that orders will be placed for castings and gear wheels on subcontractors. Meanwhile other orders will go out for steel sections and plate and similar materials, ball bearings, engines, clutches, gear boxes, pumps and all the many proprietary items which will go to make up "X."

Of course, this is giving hostages to fortune for any delay in the supply of these materials and assemblies will hold up the building of "X" and make nonsense of any planning dates hopefully worked out. The items which usually cause most trouble are certain mild steel sections and plates, high tensile steels, gears, ball bearings and roller chains, and in extreme cases it may be necessary to alter the design to eliminate some feature which is causing excessive delay—a particular ball bearing or a steel of an unusual specification.

Delivery dates mean very little nowadays and the manufacturer finding that he cannot even get promises of the supply of some material will ask M.E.X.E. for help. Sometimes—very rarely—M.E.X.E. is able to produce it from its own stocks but usually we have to turn to D.R.E.E. who combs the resources of the Ministry for us, without success as a rule. The assembly of " X " may, therefore, be held up for weeks while manufacturer and Ministry pull all the strings they can and make a search of all stockists at home and abroad for, perhaps, a cubic foot of some special steel.

Bright Ideas

When a machine is being produced, particularly if it is a new type, it is inevitable that everyone concerned will have " bright ideas " at all stages of the development. These may vary from minor alterations intended to ease manufacturing difficulties, and which hardly affect the date of completion of the pilot model, to major changes involving an entirely new layout for the machine, which will delay completion by months.

The " bright ideas " will come from all and sundry—designers, test hands, manufacturers, chance visitors, V.I.Ps., War Office and Ministry officials and University professors. They may arrive at any time between the receipt of the War Office specification and the acceptance trial and even after. Sometimes they are excellent, sometimes they have to be abandoned most reluctantly after lengthy experiments, sometimes they appear good but have been tried before and have been proved useless in practice and sometimes they are merely silly.

Now " bright ideas " are most useful and stimulating but, as in the case of an aircraft flying the Atlantic, there comes a " point of no return " when it is better to go on than to turn back, so in prototype development there comes a point when any further changes in design mean greatly increased expenditure and delay. In one case where a major change was forced on a manufacturer at a late stage, the construction of a quite new type of machine was delayed for at least a year. That year would have been much more valuable as a period of trial with a less perfect machine because we were all working in the dark and facts were wanted not ideas and arguments of which we, in M.E.X.E., had plenty.

The Trials of Testing

Eventually, sometimes many weeks after the planned date, the first pilot model of " X " is delivered to M.E.X.E. and a long period of testing begins which is as full of frustrations and delays as any other stage in the development of the machine.

Anyone who imagines that all that is needed is to put " X " to work for a month or so and then make a few modifications and adjustments is a born optimist, for upwards of two year's testing may be needed.

First of all, M.E.X.E. operators must learn the construction of "X," the details of its maintenance and how to handle it so as to get the best out of the machine. Then a series of preliminary tests are needed to get such information as weight, dimensions, drawbar pull, road and cross country performance, ease of handling, working speeds, output, etc. An extra half inch over the specified width of an earth-moving machine may be only ½ in., but it is ½ in. too much if the machine just fails to go into the aircraft that has to carry it. These preliminary tests will take three to six weeks depending on the type of plant but if weather conditions are bad and mechanical adjustments are necessary they may take much longer. At the end of this period all that has really been done is to run the machine in and to check the specification under the conditions obtaining at the time of test and little idea has been gained of the life of working parts, or of the ability of "X" to maintain its output after a spell of prolonged hard work and rough handling.

I have referred to the possibility of having to make mechanical adjustments to the newly arrived pilot model, but this is nearly always necessary and the record is held by one machine which had thirty-one mechanical faults on arrival for trial, all of which had to be cleared before work could be started.

After these preliminary tests a period is needed for robustness trials when "X" is made to work at full output for long periods under as many conditions of weather and soil as possible. This is necessary to show up weaknesses such as handling difficulties, maintenance problems, undue wear of components, excessive fuel consumption, reduction of output, etc. It is difficult to say how long these trials will take because many factors are involved, including weather conditions and breakdowns, but at least three or four months will be necessary and usually much longer.

Organizing long-term running trials is no easy matter as a few examples will show. For instance, if "X" is a mobile stone-crushing plant, nothing less than 4,000 tons of stone actually crushed is sufficient to bring out latent faults and several varieties of stone are needed at that. To buy, collect, load into the machine and then dispose of several thousand tons of stone is no mean feat for an establishment which is situated at some distance from any quarries. Again, if "X" is an earth-moving machine such as a tractor with bulldozer, the only real way of measuring its earth-moving capacity is to carry out a series of tests on different types of soil using a universally known machine, such as a Caterpillar, as a control, the two machines working side by side on exactly similar tasks with an exchange of operators at regular intervals. A comparison between the actual volumes of earth excavated by the two machines during the series of tests will give a good idea of the performance of "X." No other way will take into account the effects of weather, soil conditions and operator efficiency on performance.

Where " X " is an entirely new type of machine, much thought will have to be given to the trials, especially when there are a number of variables such as shape of cutting blades, direction and speed of rotation, gear ratios and so on, all of which may have an important effect on the performance. Trials last for months or even years if breakdowns or inadequate performance show the need for redesign.

I have already referred to pilot models of " X " as I feel that I should explain that a single model only can cause enormous delay in the testing of a machine. Where, for example, it is found that some major part of the machine, the clutch perhaps, is not sufficiently robust for the duty required of it, " X " will stand idle for weeks while a stronger assembly is being produced and the necessary alterations are being made for it to fit into place. Where two or more pilot models are available some other part of the test can go on while one model is having the new assembly designed and fitted.

Then there is the question of testing grounds, and during the last few years I have had to find the following among others :—

1. Stone quarries and gravel pits.

2. Soil conditions such as long and tough vegetation, meadow land, sand, gravel, heavy clay, chalk and shale.

3. A hard level circuit of two to three miles for high speed tractor testing.

4. Operational airfields where experimental surfaces could be tested for performance under aircraft wheels and aircraft jet engines.

5. Waterways for testing assault boats and outboard engines.

6. Steep slopes for testing the lubrication systems of tractor engines when operating at angles up to 45 deg.

7. Areas for two experimental roads and eight experimental air strips each needing a different and quite uniform subsoil.

8. Ground which could be churned up by bulldozers, scrapers and graders under trial.

9. Pot-holed roads which could be repaired and roads which needed surface dressing.

10. An expanse of country free from lights from houses, street lamps or vehicles—a rare thing in England.

Of course, " X " will not need all these but with projects " W," " Y " and " Z " which will be under test at the same time every conceivable type of ground will be called for.

M.E.X.E. has some 300 acres of ground available for trials but it is necessary to spend much time reconnoitring for special trials and enlisting the help of County Surveyors and landowners to get suitable work and ground for different tests. It is necessary also to deal with an astonishing collection of cranks who strongly object to any experimental work being done. There is the lady who used to write direct to the King on the slightest provocation; there is the man who patrols the bit of land on which he squats in the middle of our test ground and threatens to shoot anyone who sets foot over the boundary; there is the self-appointed committee of local inhabitants which writes to the Ministry at intervals to report that all the work we do is quite useless, a great waste of public money and entirely lacking in proper supervision; there are Councils for the Improvement of This and That, who declare that our bit of heather and bog is a beauty spot and first-class agricultural ground; there are people who complain of noise and dust, and many others.

Most of the complainants start, "I am a patriotic man and see the necessity for the development of equipment for the Army, but it should be done elsewhere and not near my house," and they remain unconvinced by any argument that we cannot carry out trials in the wilds of Wales or the Scottish Highlands with our base and workshops at Christchurch. "Away with M.E.X.E." is their war cry.

In order to carry out tests of the variety of experimental machines which we get at M.E.X.E., it is necessary to keep a large collection of plant including such items as :—

Tracked tractors	Mobile cranes
Wheeled tractors	Concrete mixers
Scrapers	Bitumen mixers
Graders	Power elevators
Stone crushers	Rollers and power rammers
Dumpers	Rotary cultivators
Tipping lorries	Water and bitumen tankers
Excavators	Mechanical shovels

We even have ploughs, disc harrows and seeding machines as we have had to go into the agricultural business to make-good ground disturbed by earth-moving operations.

All this plant, some 190 items, needs skilled operators, and has to be well maintained, particularly in the case of machines needed as controls during an output test, for the standard machine used as a basis for comparison must be in first-class condition.

It should be unnecessary in England to mention the weather, but this has a great effect on trials of plant and particularly on new road-making processes. Droughts, heavy rain and frost produce soil conditions which are usually the reverse of those wanted at a time when one is concentrating on a lengthy trial which calls for stable conditions. Bad weather causes much delay by flooding excavations, making approach roads impassable and ruining concrete or soil cement construction.

Acceptance

Eventually after many months of hard work and difficulties " X " reaches such a state that it works well and D.R.E.E. then has to be very firm because it is difficult to get an experimental body to stop trying to paint the lily. However, M.E.X.E. are at last persuaded to put an end to minor improvements and an acceptance trial is organized.

The War Office, represented by many branches including R.E., R.E.M.E. and Finance, and the Ministry of Supply, represented by D.R.E.E. and C.I.E.M.E., assemble to see " X " put through its paces and to check its performance against the War Office specification.

When the demonstration is over a conference is held to decide if " X " is now in a suitable state to be loosed on the troops and if it is accepted it becomes the approved prototype.

M.E.X.E. is left to wind up its task by getting the maker to produce one set of sealed drawings in ink on hand-traced negatives with four copies which will govern production of troop trial and, eventually, of Service models. For the sake of standardization these have to be third angle projection and in size and layout to the requirements of C.I.E.M.E., but, in fact, few firms use third-angle projection in this country and men in shops can usually only work to their own firm's drawings.

M.E.X.E. also has the job of preparing, in conjunction with the firm, a users handbook, which is no easy task.

Conclusion

I have described some of the difficulties of producing a new machine, but there are many others—the problem of getting staff of the right qualifications and in adequate numbers, the trouble caused when changes of policy mean alterations in priority or design, complications which arise when other arms consider that a machine designed to fill a Sapper need can easily be modified to suit their purposes as well, and the constant flow of visitors to M.E.X.E.—3,000 in one year—who cause delay and much waste of effort.

These difficulties have been greatly lessened by the excellent liaison between officers in the War Office, D.R.E.E. and M.E.X.E. and the choice of men with confidence in each other's technical knowledge, and the ability to work together is most important. Scarcely less important is the liaison between M.E.X.E. officers and manufacturers, for with mutual respect and good relations there is an enormous amount that can be done to get results, but if manufacturers feel that M.E.X.E. officers have not got good technical knowledge or practical experience or if these officers have not got good manners and a proper approach, much harm will result.

RESEARCH IN INDUSTRY

By LIEUTENANT K. E. JERMY, M.A., A.I.M., R.E.*

(Abbreviations used in this article: D.S.I.R., Department of Scientific and Industrial Research; B.I.S.R.A., British Iron and Steel Research Association.)

ALTHOUGH the war-time glamour surrounding the "back-room boys" or "boffins" has to a certain extent disappeared since 1945, scientific work continues at a high pressure in peace-time: many of the war-time projects are being further developed, but much of the effort is now naturally being devoted to the current problems of industry, and a great many of the specialized techniques and pieces of equipment developed during the war are being employed to assist and improve the operations of peace-time production. Research work is now so widespread that it would be difficult to find an article on the market, from the nail in your boot to the car in which you travel, which has not been subject to the attention of the scientist at some stage in its manufacture; in fact most goods have received the benefit of the latest knowledge of materials or processes at many stages between the raw material and the finished article.

Perhaps one of the most fascinating fields of application of war-time developments to present-day problems is that of artificial radioactive isotopes. These are substances produced as a result of the operating of atomic piles: in fact by-products of nuclear fission. A large number of the lighter and commonly-used elements, such as sulphur, carbon, iodine, phosphorus and cobalt, may be produced as isotopes, and these have the property of emitting penetrating and detectable radiation for varying periods (up to several years in some cases) while at the same time retaining their normal chemical and physical properties. They may therefore be introduced into normal chemical compounds, and will render these traceable (or "tagged") since the radiation may be measured by suitable instruments. Their range of use as research tools is considerable, particularly for applications involving solids or locations which are inaccessible by normal means, wherein reactions may be followed by the amount of tell-tale radiation emitted. Quite apart from their application in medicine (where the new isotopes may be as effective, yet cheaper, than radium in some cases, and have considerably widened the field of therapy) they are being used for such work as following the movements of bacteria, studying the absorption of arsenic by human teeth, tracing the spread of fertilizers in the soil, determining the effects of insecticides on plant life, tracing minute leaks of gas in engineering plant, study of gaseous flow in

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iron and steel melting furnaces, non-destructive testing of castings, checking of sealed packages, and problems of chemical analysis of quantities of the order of 0.00001 per cent. The possibilities of their use in all branches of industry are enormous, and in fact it is only within the last year or so that the Harwell piles have been able to satisfy the varied demands that are being made for isotopes of different elements.

Most research work is essentially long-term, involving the careful collection and correlation of information, the practical testing of theories, and the development of useful methods : this includes the rejection of schemes which are technically attractive but inapplicable for economic or other reasons. The precise results of research work are often difficult to assess : particularly in the heavy staple industries of the nation, the technical stability of existing and often long-established processes discounts the possibility of revolutionary new discoveries, and the application of research is manifested in changes in the over-all trends of manufacturing processes.

On the other hand, the new materials which are a product of our age, developed either to combat shortages of the older-established materials, or specifically to meet arduous special conditions of service imposed by advances in engineering science, offer a wide field for technical progress, and rapid advances due to the application of up-to-date research work are frequently seen.

The problems to which research work is applied are, however, not always clearly defined at the outset of the work. The techniques of "operational research," which were utilized successfully during World War II on such problems as the safety of convoys and aircraft, and the planning of the nation's food policy, are frequently applied to manufacturing processes, or the operations of an industry, in their entirety : statistical and economic analyses of the complete sequence of events will often disclose a need to improve operations which had previously been considered satisfactory ; and hence further detailed research work, or executive action, or a combination of the two, will be initiated. To put it briefly, once the need for research has been recognized, the investigators themselves must frequently seek out the problems requiring attention, by the use of their specialized analytical techniques.

The concept of industrial research implies " applied " as opposed to " pure " science, but it is difficult to draw the dividing line between the two. The solution of the most " down-to-earth " works problem will not, in most cases, be the best solution unless it embodies the latest results of " pure " or " fundamental " scientific work. Applied work, to be successful, must bring the latest developments from the laboratory into contact with the processes of industry.

Similarly it is difficult to draw lines of distinction between research specifically applied to industry, and that for Government or Service departments—the co-ordination of information between workers in similar fields is well developed, and, except where security or "confidential" barriers are necessary, the results of official or semi-official work are frequently made rapidly available to industry when appropriate.

The remainder of this article will attempt to survey the organization of research work in Britain and the bodies which sponsor it: it will also outline some current research activities, with emphasis on work which is of interest to engineers.

The Organization of Scientific Research

It must be sufficient here to say that research is performed by a large number of different organizations, principally the universities and other academic institutions, government departments, firms and industries. A certain amount of central control and guidance is exercised by the D.S.I.R. over industrial research, and, in general, there is good liaison and co-operation between different organizations working in connected spheres of interest. The different types of work in progress are considered under their respective headings below.

Research in Universities and Technical Colleges

The majority of our universities maintain well-equipped laboratories which are available for research work to the teaching staff and to full-time post-graduate research workers. These institutions are to a considerable extent autonomous in their choice of programmes of work, and it is in these laboratories that most of the advanced work in "theoretical" and "fundamental" science is pursued. Such work, however, forms an ever-progressing groundwork which is essential for many practical applications; without the benefit of the results of up-to-date theoretical work, we should not have been able to carry forward the atomic bomb, radar, or many other devices to the stage of practical use in World War II.

In addition, most universities and the larger technical colleges also conduct some more applied work, mainly on behalf of and in co-operation with industries in the adjacent districts, such as the brewing, shipbuilding, coking, electrical, dying, woollen, leather and engineering industries. Such work is generally arranged through the medium of "research contracts," under which the university agrees to undertake work on specific subjects, or "grants-in-aid," through which certain departments of universities receive financial assistance; these agreements do not normally restrict the actions of the scientific workers within narrowly-defined channels—they are free to follow their own lines of thought so long as the results produced have a bearing on the problems of the industry concerned. The ties between the universities and industry have, of late years, been strengthened through the establishment by certain large firms or trade associations of fellowships, bursaries and scholarships, tenable at the appropriate universities. These support the maintenance of scientists working either on specific projects or on general subjects of interest to the sponsoring industries, and there are normally arrangements whereby the results of such work are made available to those industries : in many cases, of course, the results receive open publication in the technical press.

It will be of interest to engineers to know that there are some twenty universities in Great Britain which maintain laboratories conducting research into various aspects of civil, mechanical, electrical, municipal, structural, naval, automobile or aeronautical engineering : the range of subjects covered, of course, is enormous, and includes studies of weirs, spillways and harbours ; erosion of river beds ; vibrated concrete ; light-weight aggregates ; frames for high buildings ; the use of ultrasonic waves in water purification ; productivity studies, including problems associated with incentives, disabled persons, industrial accidents and health factors ; steam and gas turbines ; utilization of solar radiation for heating purposes and power production ; radio wave propagation ; frequency modulation systems ; illumination in mines ; studies of engineering structures ; welding ; stability of ships ; aircraft engine cooling and reduction of noise ; and the development of "heat pumps" such as are used for extracting heat from river water to heat the Royal Festival Hall.

Research by Firms and Industries

Most large firms maintain their own research departments, and war-time conditions gave a great stimulus to the establishment by firms of new departments, or the extension of existing ones. Probably the recent developments arising from such work which are best known to the general public, have come from the laboratories of the aircraft, radio, radar, instruments and domestic heating appliance industries.

Several industries, such as the aluminium, copper, tin, zinc, electrical and timber industries, support research and development associations which conduct work centrally on problems of their industries, and are entirely financed by those industries ; these are on a somewhat different footing from the co-operative Research Associations sponsored by the D.S.I.R., which will be discussed later. Nationalized industries have mostly taken considerable care to establish or to continue arrangements for the maintenance of centralized research establishments to serve the whole industry : as an example the National Coal Board's Scientific Department has set up Central Research Establishments whose work co-ordinates and supplements that of the scientific staff at divisional and area levels.

Much of the work of research departments of firms is essentially short-term, directed towards immediate works problems, but a certain amount of more fundamental work is performed by the larger organizations, and the results of such research are frequently openly published in the technical press.

Research by Government and Service Departments

Many civil and service departments of the Government possess scientific or research organizations which cater for their own special needs ; the Royal Naval Scientific Service is a good example. The Ministry of Supply has the largest of these organizations, and it is divided into separate units such as the Atomic Energy Research Establishment and the Armament Research Department. All Sappers will have heard of the work of the Chemical Defence Experimental Station and the Experimental Bridging Establishment during the last war.

The work which is more of interest to industry is centralized under the D.S.I.R., and is divided between that of its own sections (directly controlled) and that of the co-operative Research Associations, which is assisted and partially controlled by the D.S.I.R. Both types of work are discussed in the following sections.

Research Work Carried out Directly by the D.S.I.R.

The problems of World War I first focused attention on the need for a centralized scheme of linking the applications of science to the needs of industry and the national effort, and in 1916 the Department of Scientific and Industrial Research was established as a separate Department of State responsible to Parliament through the Lord President of the Council.

The D.S.I.R. is now the co-ordinating body for Government-sponsored industrial research, whether on processes, materials, productivity, or the physiological and sociological problems of industry. It maintains fourteen of its own establishments, whose results are normally made readily available to any industry or scientific organization which is interested. These activities range from those of the National Physical Laboratory (whose work on standardization, testing of instruments of all kinds, automatic computing engines, etc., is well known) to those of Fire Research, Food Investigation and Pest Infestation Organizations.

Some idea of the diversity of the work being carried out by stations of the D.S.I.R. is given by the following items selected at random from their project lists : use of colour in factories to improve working conditions, study of factory layouts to provide increased productivity, means of overcoming the current sulphur shortage, selection of sites for new towns, work on the effects of dredging in certain rivers by studies of models, reduction of traffic accidents by improved road surfaces, and the examination of substances to prevent the staling of bread.

Of interest to engineers are the work of the Building Research Station (design of structures, building materials, efficiency of buildings), Forest Products Research Laboratory (seasoning, preservation and structure of timbers, and new developments in the use of timber), Fuel Research Organization (coal, coke, gaseous and synthetic fuels, etc.), Geological Survey (collection and mapping of geological data), Hydraulics Research Organization (tidal and river flow), Mechanical Engineering Research Organization (studies of solid and fluid materials, lubrication, wear, corrosion, forming of metals, mechanisms, etc.), Road Research Laboratory (road materials and new types of roads, constructional plant, traffic flow), and the Water Pollution Research Laboratory (testing of effluents, treatment of sewage, etc.).

Co-operative Research Associations

The idea of Co-operative Research Associations, each serving one particular industry, was first put into operation during World War I, and the number of such Associations has now grown to forty. They are bodies which, over and above the local or specialized research work carried out by individual firms, undertake research work which is of interest to all firms in their industries ; hence, as well as dealing with the broader problems of the industries which are not suitable for study by individual firms, they can, to a large extent, fill the place of research departments for firms which do not possess such departments. These Research Associations are supported collectively by firms in the industries concerned, and also receive substantial additional grants from the D.S.I.R. ; the results of their work are freely available to the sponsoring firms, and the majority of their reports also receive open publication.

It should be emphazised that the formation of any Research Association depends in the first place on collective action by the industry concerned : once this has been decided, and financial support arranged, the D.S.I.R. will add further contributions, but the stimulus towards the initiation of the Association must come from the industry itself.

The list of industries which support Research Associations gives a good idea of the range of work which is being undertaken : they range from the large industries such as iron and steel, and the branches of the textile industry, to the baking, boot and shoe manufacturing, and laundering industries.

Those Research Associations whose work is of particular interest to engineers are the British Cast Iron Research Association (mechanical and structural properties of cast iron), British Coal Utilization Research Association (domestic heating, steam raising and combustion problems), British Electrical and Allied Industries Research Association (problems of power plant, distribution of electricity, domestic and other uses of electricity, and components of electrical equipment), British Iron and Steel Research Association (production and forming of iron and steel, corrosion and its prevention, etc.), British Non-Ferrous Metals Research Association (production, forming and utilization of metals other than iron and steel), British Internal Combustion Engine Research Association (fuel testing and injection, design and testing of engines), Parsons and Marine Engineering Turbine Research and Development Association (steam and gas turbine machinery), Production Engineering Research Association (machine tools, bearings, cutting fluids, etc.), and the British Welding Research Association (testing of welds and welded structures, new welding techniques, theory of structures, etc.).

How It Works

The general methods of organization of co-operative industrial research may conveniently be illustrated by a brief outline of the activities of the British Iron and Steel Research Association ; this is, in fact, the largest of the Associations working with the assistance of the D.S.I.R., but its procedure is very similar to that of the Research Associations working in the other industries.

The purpose of B.I.S.R.A's. work is to examine critically, and to suggest improvements or innovations in, the processes of iron and steel manufacture ; consequently its member firms are the iron and steel producing firms of the U.K. Constructional engineering firms, and others using iron and steel, or firms closely allied to the producing industry, may join the Association as associate members, and a scheme of Commonwealth membership has also been introduced. The rights of member firms comprise the receipt of any research reports issued by B.I.S.R.A., the suggestion of technical problems for attention, and the ability to exert some influence on the research policy of B.I.S.R.A., usually through the Committee structure of the Association.

B.I.S.R.A. is divided primarily into five divisions, each corresponding with some particular processes or fields of activity within the industry (e.g., iron making, mechanical working, plant engineering), and there are auxiliary departments which undertake specialized work for all divisions, e.g., the Physics and Chemistry Departments which perform more fundamental studies and the Operational Research Section, which undertakes statistical and economic projects. There are also an Information Section, a Public Relations Section, and a Library which is in close touch with other scientific and technical libraries, and which offers services to member firms.

The staff, under one Director of Research, corresponds with the divisional structure, and is guided at all levels of work by the Council, Divisional Panels, and Research Committees: the membership of these bodies is drawn from directors, managers and technicians from the industry, and representatives of university laboratories or other organizations which have interests in the research programmes. The Research Committees give practical guidance on the individual projects (i.e., "keep the scientists' feet on the ground"), while the higher bodies are more concerned with direction of policy and financial allocations.

B.I.S.R.A. maintains several laboratories, some near its H.Q. in London, but the majority in the great steel-producing centres of the country, e.g., Sheffield, Swansea and Middlesbrough: it is from these that the applied research projects are organized, and the co-operation of the various local firms normally affords good facilities for the technical staff to get on to the plant (or "get their feet in the flue-dust") for observation and measurement of the variable factors of the individual processes.

Effective liaison is maintained with other Research Associations and scientific organizations whose activities are of interest to the steel industry, such as the British Ceramic Research Association, British Coke Research Association, and the National Physical Laboratory; and contact is also maintained with the research work in progress at the universities, either by a mutual system of "research contracts," or by the supporting of "bursars" (maintained post-graduate workers) in the various laboratories. There is normally valuable liaison with the research departments of steel firms, through the medium of the Committee organization, or by friendly exchanges between members of the respective staffs. The Research Association also has close links with the British Iron and Steel Federation (the "trade association" of the industry) and the Iron and Steel Institute (the industry's technical association).

Each divisional staff has its own head of research, and is organized into "teams" of research investigators under section heads. The divisional Technical Secretary is responsible for committee and conference affairs, circulation of reports, and general administrative work. Some particular instances of B.I.S.R.A. research projects in hand or completed are: specifications for steel works' cranes, handling of imported iron ores, exploration of blast-furnace working by radio-active tracers, development of new designs of steel-melting furnaces, instrumentation of furnaces, applications of oxygen to the refining of steel, continuous casting of steel, measurement of rolling forces, faster production of drawn wires, methods of analysis, testing of anti-corrosive compositions for ships' hulls, and metallurgical phenomena such as brittle fracture of mild steel, and the high-temperature behaviour of steels.

A very valuable part of the work of B.I.S.R.A. is the organization of Conferences, of which six or more are normally held per year. At these, representatives of the executive staffs of the firms, industrial technicians and " pure " scientists meet together in a common forum, and exchange information and opinions on the latest developments in theory and practice. These informal meetings provide excellent opportunities for the practical and theoretical men to fraternize in a friendly atmosphere, and each learns to respect the other man's point of view.

B.I.S.R.A. is a comparatively large organization, serving one of the major industries of the country. Its principles of work and methods of organization are, however, broadly representative of those adopted by many scientific bodies, in particular the other Co-operative Research Associations ; in every case, however, the needs of the industry concerned will determine local and central differences of operation. The emphasis in Research Association work is on co-operation and liaison between scientists and operators, between firms and the Research Associations, and between firms in the industries as far as possible.

" Any Questions ? "

Scientists and scientific organizations in general are always anxious that the results of worth-while research work shall reach the widest audience possible, and that their results should be applied to useful purposes. Consequently, a great proportion of the work done at academic institutions, Government-sponsored laboratories, and Research Associations eventually reaches the stage of open publication in the appropriate scientific, technical or trade journals. Other results, of a more confidential nature, may be released for circulation only to the industry concerned. Research Departments of firms, also, are frequently willing to allow their staff to make open publication of important results.

All large officially-sponsored research establishments maintain staffs of information and liaison officers, who are glad to answer inquiries or supply literature on their specialized work, unless, of course, the work concerned is " confidential " to specific industries or firms. So " any questions " will always be answered to the best extent of the latest information.

In addition, the D.S.I.R. has established an Intelligence Division, whose purpose is to assist inquirers with the best means of answering research problems : this division generally will direct inquirers to the most appropriate source of information, i.e., D.S.I.R. establishment, Research Association, university, or firm. The principle is to establish a direct link between the man with the problem and the scientist who can answer it.

International Liaison

Contact with work beyond our shores is also maintained by the D.S.I.R. in various ways. There are scientific liaison officers in the U.S.A. and France, and several liaison links have been established with countries in the British Commonwealth. Closer collaboration between scientists in Europe and America, and between those in various European countries, is being stimulated in many ways by arrangements made by the Economic Co-operation Administration and the Organization for European Economic Co-operation.

An interesting example of truly international co-operative research work is the programme of trials on "flame radiation" at present being conducted on an experimental furnace which has been made available by the Royal Dutch Steelworks at Ijmuiden. The study of radiation from oil flames is expected to yield useful information concerning the mechanism of heat transfer in furnaces and boilers, and the work is being sponsored by firms and research institutes in France, Holland, Sweden and Great Britain, and each of these countries has supplied scientific personnel for the work.

International scientific liaison is also fostered by the "students' exchange scheme," under which students and post-graduate workers from British universities may spend some months, usually during vacations, working in laboratories of universities and research institutes on the Continent, and vice versa in this country.

Conclusion

The sum-total of effort represented by the phrase "Research in Industry" is immense, and, although this article has concentrated on the activities of organized scientific workers only, new suggestions or developments which rightly are classed under the heading of "research" are constantly being initiated by personnel at all levels of industry. Moreover, the ramifications of organized scientific research are very extensive, and the various institutions whose work may eventually be put to good use in industrial processes are large in number and varied in character.

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SAPPERS UP THE BEANSTALK

By MAJOR W. G. A. LAWRIE, R.E.

I HAD often wondered whether the ubiquity of Sappers referred to their origin or destination. A recent visit to Kitchener's cool marble chapel in St. Paul's proved that it was both. The Rolls of Honour enshrined there commemorate fallen Engineers from all over the Commonwealth. Listed among them are the Sappers and Miners of Tehri Garhwal, Malerkotla, Sirmoor and Faridkot. It is worth recalling why they are there at all before they pass forever into oblivion, lost in the vast maelstrom of new India.

Tehri Garhwal has made great strides since the days of the brazen contractor who persuaded the State authorities to sell him one thousand trees at a rupee apiece. Of course he chose those which could be felled straight into the river, and made his fortune when he disposed of the few hundred magnificent deodars that eventually floated down to his sawmill.

It was the late Maharajah Narendra Shah, many years Chancellor of the Chamber of Princes and staunch supporter of the British Raj, who really opened up the State. He was one of the most conscientious of Princes, insisting on seeing every letter himself, which meant that it took at least four months to get a reply. It was very sad news to hear that he met with his death in 1950 when the small car he used to drive plunged over the edge of one of the new hill roads he had been instrumental in building.

In 1946 he had abdicated, after a long reign, in favour of his son Manabendra Shah, the present Maharajah, who is the thirtieth in an unbroken line going back to the ancient Rajput deities. I had tea with him the day before his installation on the *gaddi*, which took place in Tehri, the capital, a most attractive little town at the bottom of a Himalayan valley, but a good six hours drive from the nearest railway. The next morning the High Priest of Badrinath was brought down in a palanquin from his cold, lonely temple to lay hands on him before the official ceremony. At the banquet which followed the new Maharajah sat in front of an empty plate and watched his guests do justice to a memorable feast. He was now too holy to eat with ordinary mortals, enthroned as guardian of the source of the Ganges.

The only way to reach his little kingdom was to motor up from the plains through the priest-ridden city of Hardwar and on up the Ganges valley towards Rishikhesh. As the car begins to climb through the jungle one turns sharp left off the main road—I never remember a sign-post—and up a narrow track which burrows and corkscrews its way through the forest many hundreds of feet up the mountain.

When the car pushes its way out of the jungle at the top of the "Beanstalk," in place of the Giant's Castle stands the Maharajah's turreted palace, cool and detached from the world below, guarded by white peacocks who do not hesitate to show their disapproval of strangers. So detached indeed is the Palace that not only does the Maharajah function according to his own calendar, which can be comprehended with an effort, but he also insists that noon occurs when the sun is directly over his head. I used to leave Roorkee after breakfast by double summer time, but when I arrived a few hours later, I never knew whether to expect them to be still in bed or about to have tea.

The little Garhwalis in their black pill-box hats, who came in from isolated valleys in the hinterland to join the State Forces, were born sappers. After the roads and bridges they had been accustomed to build through the mountains of Garhwal it is little wonder they made light of Burma and earned a great name for themselves in the campaigns against the Japs.

Their bravery is traditional and inherited. I remember coming on a stone war memorial, far away in the hills of Tehri Garhwal, inscribed with the names of men from the farms round about who had died in the first World War.

Tehri Garhwal has been absorbed in the U.P., which now stands for Uttar Pradesh, the name chosen by the architects of new India with commendable economy to replace United Provinces, but it is good to know that the State Force sappers have been retained in the Indian Army.

Sirmoor State is up a neighbouring "beanstalk." From Nahan, the capital, you can look down through the clouds on the lights of Ambala and the glow of the Frontier Mail thundering past. The neat tarmac streets and whitewashed stone cottages used to remind me of many little Scottish villages. A tablet commemorates some forgotten expedition against the Gurkhas, mounted from Nahan, and the foundry gives evidence of past prosperity and skill in metal work, but the most impressive sign of native engineering talent is to be seen at the Jumna crossing. The first time I arrived at the bank in my station wagon it seemed quite absurd to think of getting it across the wide swirling torrent, rushing and tumbling among the boulders.

A few forlorn little figures were standing beside a lorry on the far bank. Presently a real old "Charon" got up from his charpoy, wiping his mouth with the back of his hand, and pointed to a dilapidated craft at the bottom of the steep bank. Slapping a couple of planks against the gunwale he beckoned us to embark. The station wagon just fitted across the ferry and the few inches of freeboard disappeared. Soon a pair of bullock carts turned up and were manhandled on board, with the bullocks munching in the bilges. A party bringing home poultry from the market, some soldiers with kit-bags going on leave, and finally a wedding band completed the passenger list.

We pushed off to a mournful tune feeling rather like the Pilgrim Fathers. Some of "Charon's" friends appeared from a hut and towed us slowly step by step upstream against the current. A yell from the captain was the signal for a shove and we were pushed bow first into the rapids. The band broke into a mighty crescendo as we whirled madly round, I shut my eyes and the next thing I knew was a shuddering crash as we were flung on to the shingle on the far bank. I felt there was little I could teach the Sirmooris about watermanship or the "Theory of Buoyancy," but nevertheless went home a different way.

Another memory of Sirmoor is of sitting on a red plush sofa reading *Pendennis*—the only book in the guest-house—when a car drove up with a summons to drinks at the palace. This was about 7.30 p.m. By midnight H.H. had got to the stage of saying "Call me Sirmoor, old boy," the only other guest being an A.D.C. who replaced bottles as they became empty. I got back to the guest-house at about 2 a.m., when the butler gravely announced dinner, and did my best to cope with a six-course meal served with never a yawn from the waiters. Not exactly evidence of engineering skill, but no one would deny that discipline and imperturbability are useful assets in a Sapper.

The next State was Malerkotla, founded in the days of the Moguls by a Pathan soothsayer who guessed the result of a battle correctly and was ennobled by the Emperor as a reward. In its prosperous days the state stretched from Ludhiana to Ferozepore, from Sirhind to Batinda, and had 10,000 horsemen to uphold its rights. Now it has been swallowed up by "PEPSU"—not a brand of toothpaste but the Patiala and East Punjab States Union. Even five years ago its glory had long since departed. If the state engineers had ever known how to build roads they must have forgotten, since no money had been allotted in the budget for years. This made even more remarkable the reply I got from the grey-haired chauffeur of the 1920 Rolls-Royce which came to pick me up, when I asked him what happened when the car went wrong. "Thanks be to God it has never yet broken down, Huzoor"; though that is a testimony to the engineering skill of this country rather than Malerkotla.

Nor do they show up in a very much better light over the story of the aeroplane. Even now I only refer to it in a whisper. No one dared to mention it in His Highness's presence, though he must have passed those two enormous packing cases outside the palace gates several times a day for twenty-five years. Apparently he had ordered a flying machine many years ago from Sweden or somewhere, but had failed to come to terms with the fitters who were to erect it. This is not surprising as he had old-fashioned ideas about wages. He once came to ask my advice about his head chef who had given notice. "The fellow's been with me man and boy for thirty years and now goes off and strands me just before the Resident's visit, because I refuse to pay him more than eleven rupees a month. I don't know what things are coming to." Poor old man he never survived the partition of India. He used to claim that he and the late Maharajah of Kapurthala were the only two rulers who were on the *gaddi* as small boys when the short-lived Empire of India was proclaimed by Queen Victoria and were still alive to see it come to an end in 1947.

He still kept up the old ceremonies; parting guests were presented with elaborate gold tinsel necklaces, handed to them by his A.D.C. One had to remember to have a clean handkerchief ready into which he dropped some sticky perfume, and the final gesture was to offer pan leaves done up in silver foil pinned with a clove.

But don't let me give the impression that there are no engineers in Malerkotla. We were staying in the palace once awaiting the arrival of some distinguished personages, when we were surprised to receive an imposing invitation to tea and tennis the next day. That evening we strolled round the grounds, bare and dusty after a scorching summer. We met the odd peacock and a few camels, but there was no sign of a tennis court. Next morning the A.D.C. assured us there was no mistake, and soon after breakfast marquees and potted ferns appeared. Bullock-carts of manure, mud and straw off-loaded in front of the palace and *masalchis* arrived with skins of water. By lunch-time a dozen men were treading in a revolting farm-yard mixture which soon turned into a pair of hard courts. In an hour or so they were dry enough to be marked out and when the guests arrived you could not have wished for a better surface—hard enough to give a true bounce and soft enough to be easy on the feet. Good supply organization and perfect planning are essential to the success of any engineering project.

The last of the four states to provide engineer troops for the Imperial forces in both World Wars was Faridkot, now like Malerkotla a part of "PEPSU" and also in the plains, therefore to be visited in the cold weather. When Queen Victoria presented coats of arms to the Princes, the motto chosen for Malerkotla was "Heaven's light our guide"—very correct and proper. But Faridkot has "Bholan tore the cloth" and no nonsense about it. Bholan was a legendary hero from Rajputana who conquered parts of the Punjab. On his death-bed he divided his far-flung possessions among his sons by tearing up his turban and sharing out the pieces of cloth to show how he wanted his land split up.

It is on record that the short cut through the hills from Narkanda to Sarahan via Daranghati was built by the Faridkot Sappers and

Miners about fifty years ago. The lilting sound of these names may convey something of the magic of the places to those who have never been there. Narkanda was in its prime in Kipling's days. The swells from Army Headquarters in Simla used to ride out with their ladies to the Dak Bungalow at Narkanda, 9,500 ft. up in the pines, for week-end beer and golf. From here the age-old trade route to Tibet drops steeply down to Rampur in the stuffy Sutlej valley and up again to Sarahan, the summer capital of Bashahr State, over a hundred miles from Narkanda. The new short cut reduces this by more than twenty miles and includes the memorable stage from Taklech, where blue butterflies, 6 in. across, flop around the forest bungalow, to Daranghati among the bears and wild strawberries, rising 6,000 ft. in 8 miles. His Highness of Faridkot now does the journey on a powerful motor cycle, with his Maharanee riding pillion.

During the last war the great demand for Sikhs for the Indian Army could only be met by lowering physical standards. The Faridkot Sappers and Miners were lucky in being able to fulfil their obligations without having to accept any recruits less than 5 ft. 10 in. I remember seeing a company of enormous husky Faridkot Sikhs towering above the other troops on their way home from Burma at the end of the war.

In 1946 a parade was to be held at Faridkot at which a new saluting gun was being presented to H.H. to commemorate the services of the State Forces. I arrived a few days early to check up on the arrangements and write the speeches that were to be made by the visiting general and H.H. A special arena had been built, and hundreds of distinguished guests were to be entertained in a large pavilion.

I was a bit shaken on Saturday evening to see the shell of a building standing among piles of builders' rubble. It had no doors, windows or internal fittings. There was no sign of a garden or a way in. However, the State Engineer had everything under control. Two gangs of 500 men were laid on to work alternate 8-hour shifts and by Monday afternoon the pavilion was ready, the paint was dry, carpets had been fitted, furniture installed, a gravel drive rolled in and a colourful garden had sprung up with a wall all round it.

Some of these Faridkot engineers would have been very useful on the South Bank early in 1951, and it is difficult not to feel a real regret that state organizations which could produce results in this way have had to be sacrificed on the altar of democracy.

These four states were not by any means the only ones who sent engineer troops to the Imperial Indian Army, but these examples will show that a real talent for sapper work in its widest sense may be found—Ubique.


AUSTRIAN TIROL
IMST
ÖTZTAL
INNSBRUCK
LANDECK
HOCH STUBAI
NEUSTIFT
FRANZSENN
2171
LANGENFELD
1175
GRIES
3065
AMBERGER
2135
SCHRANKOGEL
3500
BRENNER
3120
DRESDNER 2306
3300
3133
SÖLDEN
ITALY
ZWIESELSTEIN
WILDSPITZE
3342
Heights in Metres
BOLZANO
1930
OBERGURGL
VENT
KÖNIGSKOGEL
3051
Km 5 0 5

SPRING SKI-ING IN HOCH STUBAI

By Colonel E. H. T. Gayer, C.B.E.

I AM writing this for those who do not know the joys of ski-ing in April or May, wandering from hut to hut above the 2,000-metre contour, remote from the better known resorts. It also entertains me, if no one else, to try and describe, after some twenty years of ski-ing, the most wonderful ski-holiday I have ever had, in the Hoch Stubai of the Austrian Tirol in April 1951 ; but I do not intend to enter the lists of the high level controversy—touring versus *piste*. Both are the greatest fun, but as most of us go ski-ing for a holiday, why shouldn't we do what we like ?

Spring ski-ing, broadly speaking, takes place in April and May above 6,000 ft. (1,850 metres). Some of the best areas are the Silvretta-Gruppe, on the Austrian-Swiss frontier, in the Ötz mountains above Obergurgl, in the Hoch Stubai south-west of Innsbruck, in the Zillertal Alpen and many other parts of the Tirol, and in the higher parts of the Dolomiten, round Mount Marmolata. The advantages over ordinary ski-ing are the long days, usually in the sun, though the weather can be very changeable in April and May ; wonderful snow conditions, powder and *föhn*, when everyone feels an Olympic champion ; constantly changing snow conditions varying from ice to wet sticky porridge, when the professional ski-instructor may take a toss (I have not seen this happen often, but it raises the morale more than much alcohol), and best of all, the wonderful air and scenery, in the world between 7,000 and 10,000 ft. or more. Peak upon peak rise against an azure sky, glaciers and seracs flash in the sunlight, amid great wide snowfields practically untouched ; rarely do you meet more than a dozen skiers in a day's tour. If you are a skier, I hope I have roused your interest, if not your enthusiasm, by now, so let us start planning our spring tour.

Firstly, do not go on a spring tour if you are a complete novice, you won't enjoy it and you will spoil it for others. Unless you are unusual I would not start on any ambitious programme until you have had two or three seasons. Some previous knowledge of the country and the language will increase your enjoyment, but are not essentials. A guide or a member of the party who is as proficient and knowledgeable as a guide is necessary. Lastly, the most careful choice of your equipment and belongings, because you are going to carry all of it on your back some of the time, and some of it all of the time. You can be tough and cut yourself down to bare essentials in which case you can probably do three weeks on 20 lb.; on the other hand if you are carrying 30 lb., or more, you will have to be tougher still when you have five to six hours to do from one hut to another, but the frills are a matter of personal taste, so let us get down to the detail of essentials and desirables. We are aiming at being entirely self-contained for three weeks, staying most of the time in the high huts, but probably staying several nights in each hut. Most huts provide good food and drink, are warm and comfortable but not luxurious. It is advisable to inquire if the particular hut to which you are going is *bewirtschaftet*, (that is, in working order) at the moment. They are not all open all the year round, and though you can always break in, and usually find fuel, you will be hungry and somewhat dispirited, if you have been eagerly anticipating a hot meal and a glass or two of *Schnapps* for the last hour or so of a long climb. (There is a most comprehensive booklet published yearly in Austria, giving complete details of every hut in the country: *Ski Taschen=Buch der Alpenvereins—Mitglieder.*)

Let us now make out our lists. They do not include what you may choose to wear on the journey out, but they include everything you are carrying or wearing when you leave all forms of transport, except your own legs, to go up to your first hut, probably a three or four hour climb.

Our first list is the ski-ing equipment. You are going to depend on it so it must be good and in repair, though your guide will always be able to do minor repairs on the spot:

Skis: Hickory, with good steel edges, projecting about ½ mm. beyond the wood. Don't have your skis too long, 2 m. 5 cm. or 2 m. 10 cm., a shade broader than racing skis, and not too whippy.

Sticks: Aluminium are probably the best as they are less likely to break than wood. See that the stitching of the thongs is sound and also the attachment of the "baskets" to the sticks. I like rubber or plastic tops better than leather.

Skins: Fit them to your skis and see that the attachments are sound. I think plush grips better than sealskin. I don't believe in climbing waxes or in skins that just "stick on." These are all right for short climbs, but for several hours a day, good well-fitting skins will save you an immense amount of unnecessary exertion.

Boots: You must have proper ski boots, waterproof, roomy for two stout pairs of socks, but tight enough that your foot does not shift about sideways. I like them cut low in the ankle and with ankle straps sewn to the top of the heel and not on to the side of the boot. A felt or double thickness of soft leather sewn round the top of the boot makes them grip without chafing.

Rucksacks: You will need a large rucksack to carry everything, and a little one for daily trips from your hut-base of the time.

I prefer the frame type like the Bergen, or the ex-Army equipment one, which is first class. It must be strong and waterproof and with several outside pockets, so that you only have to pack and unpack the main compartment when you change huts. Many people prefer the type without a frame. Going downhill it is better because it is less inclined to swing sideways or away from your back, but I find it heavier on the shoulders for climbing.

The following items are necessary, but your guide should have them for the party :—

Spare binding—spare tip—waxes, cork—Boy Scout knife—spare pieces of steel edge and screws, waxed thread, little leather strips for repairs, saddler's needles.

Now for your clothes and etcetera :—

Ski-ing trousers? Very pansy *Vorlage* are not necessary, but they must be wind and wetproof.

Wind jacket: Light, wind and wetproof, with zip-fastening pockets and a windhood.

Three shirts, with long sleeves—three pairs pants—three vests—three pairs thick socks—two pairs thin socks (real silk are the warmest)—a belt, webbing is better than rubber or leather—thick pullover—thin pullover—scarf—headband (like a scrum-cap, lighter and as warm as most other forms)—Two pairs sun glasses (get good ones—one pair with sides. You *must* wear glasses, and you may easily lose or break a pair. You will need side pieces against the glitter of glacier-ice)—goggles (These are to wear when it is snowing. The only effective ones I know are American Aviation goggles with three interchangeable coloured talc eyepieces. I bought them in Innsbrück for under a pound. What you get must fit, and be ventilated all round or they constantly fog up.—two pairs gloves (one woollen with fingers, one fleece lined leather overgloves)—P.T. shoes or a very light pair of shoes—handkerchiefs—towel—pyjamas—old grey flannels—washing and shaving things—sunburn lotion (It is tremendously important to have the right stuff and use it frequently or lose all your face. Nivea is not good enough ; the best I know is Tschamba-fi, which is obtainable anywhere in Austria.)—cream for the lips (Also essential, but the right stuff, not the girl friend's face cream. " Labazan " or anything sold in Austria against " glacier-burn " will do.)—toilet paper—chocolate slabs—boiled sweets—flask—first aid tin (Robert Lawrie of 48 Seymour Street, has an excellent little one for 2s. 6d.)—tin of tea (if you're fussy and don't like the local stuff)—bottle of whisky (You can always make the guide carry this, on the grounds that it is safer that way !)—cigarettes—maps—pack of playing cards—book to read—money and passport—spare bootlaces—dubbin—camera, etc.—small electric torch (there is one like a fountain pen which costs about 4s. 6d.).

If you have all these, your full rucksack should not weigh more than 30-33 lb.; obviously if the party is two or three, there are certain items which you can share. Some things you can do without altogether, but remember that the weather can change. Within ten minutes you are stripped to the waist and sweating, and then none too warm in a pullover, shirt and windjacket. Now that the plan is made, let us start for the Tirol as I did in early April. Four hours by plane, or twenty-four by train and boat, will take you to Innsbruck from London. I went by plane and came back second class with sleeper in the Arlberg express, the former was between £4 and £5 cheaper.

I got out of the bus from the airport about 4 p.m. in the middle of Innsbruck, where Andreas, a ski-ing and swimming instructor by profession, met me. We were at his home four miles out in the lovely grounds of Schloss Ambras before 5 p.m., where the serious business of packing for the morrow was to take place. I stayed in great comfort in the village, as the plumbers were in at Andreas's home installing a bathroom after some four centuries, and as Andreas's mother remarked, " They do not work quickly here in Austria."

The plan for our three weeks was to go by bus the next morning to Obergurgl, and spend five days there in a small *pension* in civilization, while I was put through my paces by Andreas, and got fit enough for the long climbs and tours. I think this is wise for anyone, however young and fit, because ski-ing and climbing use different muscles from other forms of sport. It also breaks you in to the altitude. At 7.30 the next morning we caught the local bus into Innsbruck where we waited near the Golden Roof, under the vaulted arcades of old Innsbruck, in pouring rain, for the bus to Zwieselstein in the Otztal four hours away. We were soon joined by a young man tacking down the street: however, his goal was not the bus but I imagine his bed; he left us slowing and erratically at eight o'clock on Sunday morning, after what must have been a very good party. Half-way to Zwieselstein, the rain turned to snow all up the lovely valley of the Ötz, though the spring heather was everywhere in full bloom. Shortly after Sölden, on a steep little hill, the bus failed to make the grade on a corner and we slid back nearly off the road. Fortunately there was some gravel near by and, after all the able-bodied male passengers had got out to push, we were going again after about twenty minutes. We were in Zwieselstein, just under 5,000 ft., by 12.30 where we had a hearty lunch in the *Gasthaus Zur Post*, before going on to Obergurgl on foot. It is the highest

Photo 1.—Stubai Area from Zuckerhütl (3505 m.).

Photo 2.—Sulzenau Ferner.

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Photo 3.—Dresdner Hut.

Photo 4.—Franz Senn Hut.

Spring Ski-ing In Hoch Stubai 3,4

village proper in Europe, and lies at about 6,300 feet. There is a jeep road in summer, but we walked up on the snow, sending our skis and rucksacks on by horse-sleigh. It took us about 2¼ hours and when we passed the little village of Untergurgl, which I had last seen in the autumn of 1949, we found the church and half the houses gone with one of the terrific avalanches caused by the unprecedented snowfalls of February. The first two days in Obergurgl it snowed. This could not have been better, as it kept me hard at work practising under my taskmaster, and we spent the time up and down the ski lift, which goes up about 400 ft. It also ensured that up in the high mountains there would be beautiful new snow. In fact after these first two days we had almost perfect weather the whole time, and the excessive snows of February ensured that there would be ample for many weeks to come. Our last three days in perfect sunshine we did a two or three hour climb each day, usually overlooking the Gurgl glacier on which Professor Piccard descended in 1934 in his stratosphere balloon, having attained the then world altitude record. On the sixth day, we skied down to Zwieselstein, and went half an hour by bus to Langenfeld, from where we began the more serious part of our trip. The first climb with a full rucksack is always a bit tiring, and we left Langenfeld about 3.30 p.m. on what I was glad was a rather dull afternoon. Here, Andreas made the only tactical error I have known him to make, and I have skied and climbed with him for many hundreds of miles. After a few minutes, he decided to make a short cut. There was no snow yet, as we were below 5,000 ft., so we were carrying rucksack, skis and sticks. Andreas shot up a narrow and slippery path, where one hand was needed frequently by me to pull myself up. I had thought this manœuvre was for fifty feet or so, actually it was a good 500 vertical and seemed three times as long. Exhausted and cross, I reached the track again and told Andreas that I would prefer to die ski-ing towards the end of our tour. Along the trackside, as I have often seen elsewhere in Roman Catholic countries, were little painted shrines portraying the stages of the Cross. Andreas's irreverent reply was that I had already accomplished seven and with that we started off for the three or four hour climb up to the Amberger-Hütte, which is at about 7,000 ft. (Some days later Andreas told me that he took the short cut purposely to see what sort of shape I was in.) Half an hour later we reached an enormous avalanche across the track, which must have completely isolated the village of Gries, an hour further on. Through it, entirely made by hand, was a tunnel about sixty yards long, and eight or nine feet high and broad, its inside more like ice than snow. We reached Gries in Sulztal (there are at least four other Gries in Tirol), about 5.15 p.m. and I, still suffering from the short cut, said we would adjourn to the local for a meal and probably stay the night. The delightful little *Gasthaus* was apparently run by the pastor, as well as the Church, a dual control system I have not met before. After food and drink, I felt less rebellious, and we started off again soon after 6 p.m. We did not reach the Amberger hut until after 8 p.m. but tired though I was, the last half-hour's climb on the snow, above the treeline, and in moonlight, was very lovely. But better still, was a warm welcome from the hut owners—friends of Andreas, *Schnapps* and a large meal and to bed by 9.30 p.m.

The Amberger hut is a solid stone building lined with wood which makes it warmer. It can sleep forty or fifty in dormitories (*matratzenlager*) or in small cabins. Andreas and I had one of the latter, with two berths—one above the other ; it was fitted with a locker, washstand, a chair, shelves and hooks, and was spotlessly clean and comfortable. Food was good and plentiful though plain and there was beer, *Schnapps* and red and white wine. During the winter months everything not pre-stocked, has to be carried up on a man's back from Gries—two hours away. I met the son of the house arriving one evening with an immense load. He was a huge and very powerful young man of twenty-seven or so, and he told me his load weighed 60 kilo or about 130 lb., which at 6,000 ft. is prodigious. We based ourselves on the Amberger for five or six nights, and spent two nights away at the Dresdner hut, which was about 3½ hours distant and a few hundred feet higher. Every day the weather was perfect and we made a tour with a three or four hour climb, a rest of probably an hour at the top, usually on a knife-edge ridge between 10,000 and 11,000 feet, where we ate, and then a marvellous run-down, the best of which I will describe. In the spring when the sun is extremely powerful at these high altitudes, the knowledge of a highly trained instructor makes an enormous difference to the enjoyment of the day's ski-ing. One should set out so as to start down from the top, to get the snow at its best. This on a really hot day is probably about 11.30 a.m., and one is back at the hut in the early afternoon, after a start at 7.30 a.m. But it will depend on many little things ; whether it froze during the night and if there was any wind. If the run-down has been in the shadow until late, the first 2,000 ft. may still be rather icy at 11.30 a.m., and it is better to wait half an hour more when it will be powdery and perfect. Or again one side of a slope catches the sun's rays at a different angle from the other ; where the rays have been more vertical the snow will be softer. I have been in wet sticky snow by asserting my independence, and Andreas 300 yds. away has jeered at me from powder snow. On certain steep slopes one must be clear of them before the sun is too hot or they may avalanche. With a good guide, even in dangerous snow conditions, the risk of being caught in an avalanche is extremely small, if you do what you are told.

I think the best of many lovely days was on 17th April up to the Windacherkogel. We left the hut about 8 a.m. with the valley still in shadow and cold, as we had ahead a four hour climb, rising about 4,000 ft.—the longer we were in the shade the better. We always ate before a long climb, what Andreas called a "strong" breakfast, which was eggs and bacon added to the normal coffee and rolls. The way goes for half an hour or more up a comparatively flat valley with the Schrankkogel peak, about 12,000 ft. straight above, it then ascends more steeply and the snowfields widen out to nearly a mile between a semi-circle of peaks all near 11,000 ft. Already we are on the Sulztal glacier, though there is no obvious sign for another hour till we pass by a tumbled mass of ice seracs, shining blue-white in the sun. By now, about 9.30 a.m., we are in full sun and stripped to the waist. The light and shade on the snow slopes as the sun mounts higher is fascinating to watch; now and again a light flashes from an ice face, blue or green, as the sun's rays move on to a glacier. There is not a soul in sight, except four or five skiers on the far side of the snowfields, and complete silence except for the faint slither of our skins on the snow. When you climb several hours a day, it pays to reduce exertion to the minimum. The first rule is to climb at a steady rhythm, slowly. Never hurry in the mountains, it wears you out; the higher you get the slower becomes your rhythm, but what you do must suit yourself and a good guide will adjust himself to your pace. My critical altitude is round about 9,500 ft., above which I find a sudden steepening of a slope leaves me breathless. In ordinary snow and when the slope is not very steep, slide your feet, do not lift them, and do not take too long steps. Before you start, if you are wearing kandahar or similar bindings, make sure they are hooked to the upper notches, so that the heel is free and not tied down as in the running position. When the snow is icy on a very steep slope, you must lift your ski slightly, with a short step, and almost stamp it on to the snow. At the same time stand up with your weight vertical to the slope; the steeper the slope, the greater the natural inclination to lean forward, and then you slide backwards. There may come a time when the snow is so icy and so steep you just can't hold it. I am not too proud to take off my skis and carry them. In the Stubai many of the tours have an extremely steep little climb, 50 to 100 ft., just at the very top, when you reach the knife edge at 10,000 ft., which is the crest of the ridge. To-day we reach the top at about 10,500 ft., without a steep knife edge, in 3½ hours, and there on the far side is a view for nearly a hundred miles. Below is the Otztal, with the ski resort of Hoch Solden far beneath us, the Wildspitze, Piz Buin in Switzerland, and part of the Dolomites. There is no wind, but just a faint coolness in the air, so that one is foolish not to put on a shirt and even a pullover. You will find the toughest Tirolean very fussy about this at a height after a long climb, if there is the faintest breath of air. Curiously enough, we are not quite alone, there are one or two choughs and some mountain finches, and then a lovely sight—a tortoiseshell butterfly came and sunned itself on the snow. An hour's rest and something to eat, chocolate and an orange, and we started down about 12.15 p.m. our 4,000 ft. descent. There is nothing difficult about this run, but there is an empty snowfield of perfect powder snow. We take part of it straight and then slower down a mile long slope, where in this snow, every turn is easy, and in a few minutes we are down to the seracs. But the day is so perfect that we take our time and are back at the hut by 1.30 p.m., very thirsty and hungry. We have all been told never to gulp an ice-cold drink when very hot ; I like the Austrian custom of circumventing this. Drink first a *Schnapps* which warms the inside and then your beer.

In the afternoon we may have some practice on a near-by slope, and Andreas usually has a swim in the pond of comparatively warm water, still surrounded by snow a metre and more deep. In and around the pond are innumerable frogs who hop miles over the snow to reach the stream from the pond where it comes out much lower down the valley. In most huts water is scarce, do not expect to do over much washing, and the only hut I know with a bath is the Franz Senn. Twenty-four hours' notice is needed and then a magnificent hot bath will be made ready.

We saw little of our fellow guests at the hut, except in the evenings. An English couple, the only two we met in the Stubai, who were on holiday from the oilfields in Mosul, the man bore a strong resemblance, complete with beard, to D. H. Lawrence. There was a cheerful noisy party of youngsters from Vienna who got stick, on the snow and in the hut, from their elderly ski instructor when they became too obstreperous, and for one night there was a party of French Chasseurs Alpins of the Army of Occupation. They were doing a long tour including ski-mountaineering, equipped with ice-picks, crampons, red avalanche lines, etc., and looked very fit and business-like.

In huts there is no night-life proper, and usually most people are in bed by 10 p.m., but one evening two professional musicians, a singer and a guitar player, on ski-ing holiday too, entertained us all for three hours. A most accomplished pair, who sang Viennese, Tirolean, Italian and German songs in the warm friendly atmosphere which is the special charm of an Austrian mountain hut. In most huts are the highly pictorial German playing cards, draughts and chess and a few books in various languages. In the Franz Senn is an 1845 edition in English of several of the Waverley Novels.

Our two-day visit to the Dresdner hut (Photo 3) was pleasant and uneventful, but on our return journey it was snowing and misty, and warm enough to start soon after 7 a.m. to get through a narrow couloir where later there would be danger from avalanches. At the Dresdner was a party of twenty or thirty young Austrians under instruction in the art of removing ski-ing and mountaineering casualties. On 20th April we left the Amberger hut for the Franz Senn, a six-hour journey, with a 4 to 4½-hour climb, over one of the nasty steep knife edges at a little over 10,000 ft. This was a full rucksack day, and we left at 7.30 a.m., before the morning mist had lifted, but the sun mounting behind it and lighting up a summit every now and then, produced a beautiful effect, in which all sense of distance was lost. The first hour, the climb was steep and it had frozen hard during the night. I found with the heavy rucksack the surface so slippery that I took off my skis and carried them until we got into the sun. It was again a perfect day, but after nearly 3½ hours I was thankful to reach the knife edge. Ski-ing down with a 30-lb. rucksack needs considerable practice. It is not difficult until one turns, but it is very easy to be thrown out of balance. I fell quite a number of times and, if on my back in snow that was at all deep, was like a beetle unable to get up, unless I took the rucksack off. The Franz Senn (Photo 4) is perhaps the nicest of all Tirolean huts, big, with a bath, and a better class cuisine than most. It was built about 1870 in memory of Pastor Senn, a fine character and great mountaineer. It has been always in the hands of the Falbesoner family, who still own it. It lies at about 7,300 ft. on a shoulder above the valley, completely protected from avalanches and with wonderful ski-runs in every direction on the neighbouring glaciers. The normal approach is by the toy Stubaithal railway from Innsbruck, through exquisite scenery to Fulpmes, on by bus to Neustift, and then five hours on foot up to the hut, and by this route we returned after four or five days in the Franz Senn. The weather remained perfect throughout and the sun so hot that though by now burned mahogany, making up the face was still necessary two or three times a day. On arrival I had one day's rest, and I am sure one day a week off is much better for most people. On the last day coming down an easy run in a bad light I lost Andreas's tracks. It was that curious half light when to me, with or without dark glasses, I cannot judge any slope, and for a mile or more I skied abominably at a funeral pace. Half-way down, I found Andreas with his head in his hands saying, " I have watched you ski for four years and now I cannot bear to look any more." In a somewhat strained atmosphere he led the way down a steep route home which I did not know, but the sun came out. The snow was deep and beginning to get soft, which I never like, but for some strange reason, I did the deep snow turns left and right in effortless style and Andreas shouting " *Prima*, *prima*, you ski the worst ever and now better than I have seen before." The long trek down to Neustift the next day was hard work as the snow was abominable and very much cut up; here we passed numbers of huge avalanches across the tracks, relics of February, likely to remain most of the year. Tumbled blocks of dirty snow, full of broken trees and debris, but as far as could be seen no damage had been done to villages. In Neustift itself, where we had lunch, a hugh avalanche, still 12 or 15 ft. high, had stopped a few feet from the school. By tea-time we were back at Ambras, after three weeks cut off from all the pinpricks of civilization; the most perfect and exhilarating holiday I know, with the luck of wonderful weather and snow added.

Now that we have returned to earth, the important but mundane consideration of cost must be faced. The return journey, London to Innsbruck varies from about £16, third class to £40, first class. Our trip, which included a reasonable amount of beer and wine each day and a few extras to eat, worked out at about £1 per day per head. If very abstemious this could easily be reduced to 10s. per day. If you are a member of the Austrian Alpine Society, at a subscription of 10s. per year, all accommodation in the huts is half price, this concession does not, of course, apply to food and drink. (Major Ingham, 143 New Bond Street, is the Secretary of the British branch of this club.)

I hope this may encourage some to go ski-ing in the huts in spring. I have done it three times, and my one regret is that I did not do it before. 1951 was the best year because the weather was perfect; it is not every year that one wants to be lost in mist and snow near 10,000 ft. on one of those muggy days which avalanches like—even though it is delightful to contemplate in retrospect.

Note.—The R.E. Ski and Mountaineering Club held a ski-ing meet in this area during the spring of 1952 and the photographs now published were taken by Captain H. F. W. L. Vatcher, R.E., at that time.

"TIME SPENT IN RECONNAISSANCE"

A Desert Incident

By Colonel J. V. Davidson-Houston, M.B.E.

AS we crossed the line of dunes and saw nothing but more sand beyond, the term "hot pursuit" began to hold a literal meaning for us.

Rashid Ali's rebellion had been broken, and Iraq was at last freed from the risk of German intervention, but there were dangerous enemies yet to be accounted for—Colonel Yakub Ali al Massawi was one of those at large, and our column had been charged with the task of apprehending him.

It would not be an easy task, for Yakub Ali had a considerable following. His father had held high rank in the Turkish Army and had fought against us during the first world war ; his son, although reputed to have owed his promotion to family influence, had inherited a pro-German and anti-British tradition with which we had still to reckon.

He was now believed to be commanding a force of at least battalion strength in the desert country west of the Euphrates, and thither we had gone to find him. Our column, consisting of a squadron of armoured cars, a field battery, and a lorried infantry battalion, was without benefit of "Air," partly because there were no aircraft to spare, and partly because the enemy was lying up by day and might have been warned of our approach. With the small forces available to us, surprise was essential to success.

That morning an intelligence report had come in to the effect that Yakub Ali was harbouring at Djuleila, a village surrounded by date gardens and a few acres of cultivation, where the wells were known to be adequate for a small force such as his.

Djuleila still lay some seventy-five miles to the north of us, and as we drove through the choking clouds of dust we were buoyed up by the excitement of the gamble we were taking. On this morning's plan depended the success or failure of our mission, the rounding up of the slippery Yakub Ali ; and the plan itself was a gamble. It all happened through a chance remark made by Peter B—— at the after-breakfast conference.

"Of, course I know Yakub Ali personally, sir," he observed, quite by the way.

The column commander fixed him for several seconds with a look of disfavour. " Why the devil didn't you say so before? When did you know him?"

"Just before the war, sir," Peter answered, " When I was with the Military Mission—Yakub Ali came on several tactical exercises which I was at."

The commander leaned forward and regarded Peter attentively—" Tell me about him," he demanded brusquely, " What sort of a man is he? Have you ever watched him solve a tactical problem?"

Peter screwed up his face, partly in concentration of thought and partly to remove a persistent fly. " Well, sir," he began slowly, after a few moments thought, " He was a conceited, idle sort of chap; had a good deal of backing in high places, and thought a good deal of himself and his own opinions."

" What about his tactics?"

" He had none. What I mean to say, sir, is that he was really too idle to think; so he would try to fasten on to a stock solution of a problem, and then trot it out as if it was his own."

The commander, whose brow agitation always bejewelled with drops of moisture, especially in hot climates, did a little rapid mopping and asked: " Do you know what stock solutions he has got into his head? What about the defence of villages, for instance?"

Peter grinned. "As a matter of fact, I helped to teach him that one. The problem was the defence of Bir en-Narqa, which is a pretty scattered sort of oasis and had to be held by a battalion with a section of guns. I had prepared the exercise, and my solution was meant to teach the principle of concentration. The surrounding country was open desert, so that the school solution was to keep practically the whole force concentrated and to organize a defensive position on the assumption that an attack would come from the direction of the nearest water supply. In the unlikely event of the enemy making a longer and more difficult approach, information should be obtained by patrols in time to allow a change of dispositions."

The commander grunted. " I don't know that I should have given you full marks for your solution at the time, but I will give you full marks now. Warning order . . ."

The impending operation bore a marked resemblance to Yakub Ali's exercise. His camp at Djuleila was located among scattered date gardens and cultivated patches, and practically surrounded by desert. In ancient times canals had brought water from the Euphrates, and must have irrigated a considerable area; but for many centuries they had been dry and silted ditches, and the oasis was dependent on a large number of wells from which the water was raised by squeaking wheel-lifts. It was obvious that the easiest approach as regards both water supply and terrain would be from the Euphrates, and that Yakub Ali, if true to type, would have disposed his forces to meet this threat. The commander decided to swing away from the river and to approach from the south-west, covering the last forty miles under cover of darkness, which would bring us before dawn to the Djebel Hamza ridge. The map showed this as a low range of sand hills covering Djuleila, and separated from it by some three miles of flat desert. It was probable that our enemy would push patrols out to these hills but would not attempt to hold them ; it was therefore decided to take them during the night, quietly kill or capture any enemy that might be there, and prepare for a surprise attack at daylight. Speed was the essence of the operation in order to prevent our quarry from making his escape, and there was no time for detailed reconnaissance or complicated manœuvres.

Peter, of course, felt himself responsible for the success of the venture, and hereafter carried a look of suppressed excitement not unmixed with anxiety.

Owing to poor wireless conditions, and the possibility of having to make a sudden change of plan should we be discovered, the commander was remaining with the main body ; sending Peter ahead with the armoured cars to make a reconnaissance and transmit early information on the ground and anything he could find out about the enemy. We halted for an evening meal just after dusk, while the armoured cars trundled away into the darkness on their way to the Djebel Hamza.

I travelled in the commander's car during the approach march, and more than once he, too, showed a little anxiety.

" I wonder how far Peter's character appreciation is right," he muttered. " He's a bit inclined to be slap-dash and jump to conclusions, although he's one of the keenest and most loyal young fellows one could wish to have. Well, one has got to take risks in war, and this is a fair one. The great thing about sending a military mission to potential enemies is that you teach them to fight in an orthodox way—much easier."

We made fair progress during the night, although we had to steer by compass and there was no moon. The desert was level and firm, but there were patches of stony ground which slowed down our advance considerably. At about four in the morning, however, a report came from the squadron that they were held up by a stretch of soft sand near the foot of the hills, and our next halt was an anxious one.

" Damn it," grunted the commander, as he got out of the car and stretched his legs. " This probably means the trucks will get stuck, or we shall have to wait till daylight."

Our forebodings were by no means relieved when Peter returned in person to report that the obstacle was nearly a mile wide and that, although the armoured cars were picking a route through it by a judicious mixture of feeling the way, laying tracks, and towing, it would be at least two hours before they could be over.

It was in fact already daylight before the armoured cars were across, and the main body started its next bound towards the obstacle. The commander was unable to conceal his disappointment, but as there was still no evidence that we had been observed, he determined to push on with the operation as already planned. The sun was well up by the time that the Djebel Hamza was made good, and we anxiously awaited a further reconnaissance report from Peter. In the meantime the battery commander had gone forward to set up an observation post in order to cover our final dash across the plain to Djuleila.

During this interval the main body pressed forward to the sand belt and began to cross. This entailed dismounting the men and manhandling the trucks over the bad patches. The guns went into action in positions enabling them to clear the crests of the Diebel, but in the middle of this came a shattering message from Peter.

"*Low ground south of Djuleila flooded or water-logged to depth of approximately 2,000 yards across whole front and apparently continuous to Euphrates. Am reconnoitring approaches from west.*" This was almost too much for the commander, who had not yet learned to expect the unexpected in war. "Hell take it," was his comment. "Every minute's delay means we may be discovered ; our only hope is to keep going. Hesitation will be fatal." The murmuring something about "flexibility," he rapidly issued orders for swinging the advance of the main body away to the left, so as not only to avoid the Euphrates or the adjacent flooded ground, but also to skirt the Djebel Hamza and the soft sand at its foot. This change was a great relief to the dismounted infantry who were very hot and had hitherto succeeded in getting only a proportion of the trucks across. In the meantime, the armoured cars were to lie up in the hills and no advance was to be made beyond them until the main body was ready to attack. The gunners were to remain in their present positions and be prepared to put down a concentration on the oasis as soon as the signal was given.

The hot air scorched our faces as we bumped across a stretch of stony desert to the west of the Djebel, and the dust rose so generously that we were forced to undertake a very wide detour to conceal the movement from Djuleila. As we rounded the end of the range we were relieved to find no water, and were met by an armoured car which had reconnoitred the onward route.

A large wadi far to the left of the oasis was now selected as the forming-up place for the infantry attack, and it was decided that the gunners behind the Djebel Hamza should fire a concentration for ten minutes as soon as the former was ready. After this, it was hoped, the main body could dash across to Djulaila without much difficulty, the armoured cars pushing on to the north to prevent Yakub Ali's escape in that direction. The commander and I then returned to join the battery commander on the Djebel Hamza ridge where, only three miles away, the date palms and flat-roofed buildings shimmered tantalizingly before us, yet cut off by a wide sheet of water which seemingly stretched away to the invisible bed of the Euphrates.

The sun was high, and there was little shade, so that the commander stood impatiently by the wireless set, intermittently glancing at his watch. It was two hours before a message came that the infantry were in position in the wadi, and ready to attack.

No movement could be discerned at Djuleila, even through binoculars, but now at last we were to discover whether our quarry would stand and fight. The order to fire was given, and the first shells whistled overhead on their way to the target.

And now the most extraordinary thing happened. Several shells fell short, dropping into the shallow lake which had obstructed the advance. Instead of the expected spouts of water, however, a cloud of dust arose at each point of impact. The shimmering sheets of water, in which no one had yet set his foot, were nothing but a mirage, destined to fade from existence in the cool of the evening.

The mirage had saved Yakub Ali. He had evidently spotted the dust thrown up by the column as it left the shelter of the sandhills, and not a single Arab soldier remained in Djuleila by the time the bombardment had begun.

As for Peter, he considered himself lucky to be with the outflanking column during those first few minutes when the commander watched the water become dust.

FURTHER REFLECTIONS ON THE PROMOTION OF N.C.Os.

By BRIGADIER R. H. F. DUCKWORTH, C.B.E., M.C.

I READ with interest the article in the March, 1952, issue of the *R.E. Journal* on this subject and hope further reflections based on my own experience may be of some use to those who are faced with this problem.

In my thirty-four years' service I had on one occasion so many N.C.Os. I did not know what to do with them, and several years later I had practically no N.C.Os. at all and did not know how to carry on.

The first case proved that good N.C.Os. without enough scope to "command" and no "responsibility to shoulder" rapidly go to seed and the second case proved that in your ranks you always have good N.C.O. material. I had to give Sappers the responsibilities of Senior N.C.Os. and the results were astonishing to everyone concerned.

Given the right circumstances the potential N.C.O will show himself to you. I especially say "show himself to you" as opposed to saying "find him," and I hope I shall make myself clear before I have finished.

The most important thing is, of course, to make as certain as is humanly possible that you are training the right man, especially under the circumstances visualized in the previous article on the subject.

TOO MANY N.C.Os.

In 1922 I was given command of the 1st Field Squadron, then the only squadron in the Corps, affiliated to the Cavalry Brigade in Aldershot. It was a cadre left over from the war—160 horses, 15 to 20 sergeants and lance-sergeants, 4 trained mounted sappers and the remainder borrowed recruit drivers from the Mounted Depot. Very soon I received orders to form H.Q. and one troop, about forty-five horses strong, and sufficient transport for two half troops, each one tool cart, G.S. limber, G.S. wagon and H.Q. transport—say one hundred horses and men.

It must now be pointed out that there was at that time a "mounted roster" of N.C.Os., small and select (as we thought) which filled vacancies in the establishment and a few vacancies at Chatham. All "mounted sappers" were volunteers from Chatham recruits and from the divisional Field Companies.

It will be appreciated that with an H.Q. and one troop I needed only a S.S.M., S.Q.M.S., one troop sergeant and, say, two lance-sergeants and the odd corporal and lance-corporal. I had, however, some ten to twelve sergeants and lance-sergeants, all with war experience, several of whom had been acting S.S.M. and S.Q.M.S. and R.S.Ms. to Cs.R.E. of Infantry Divisional Engineers. I also had some first-class corporals of long service and good "young" lance-corporals of eight to twelve years' service.

I soon realized that my senior N.C.Os. were going rusty and my junior N.C.Os. could never develop under these bad conditions and also that my chances of finding future junior N.C.Os. to balance the roster were very remote. In fact I had to get rid of my senior N.C.Os. and find extra employment for them by all means possible, and that did not mean that disgraceful trick of sending your bad N.C.Os. to other units. Perhaps 25 per cent of them were not "G" and it must be remembered that unless they volunteered for the "dismounted" roster, I could not send them to Field Companies—none volunteered.

To solve these problems I adopted the following steps and after picking my selected men :—

(i) Sent my good N.C.Os. on courses to still further improve them in peace training after the war—it did them good then and the unit later.

(ii) Sent my best N.C.Os. to T.A. and O.T.C. camps and tattoos and every possible activity that asked for them. It did them good, they went away and threw tremendous chests and returned better men with great credit to the Sappers and my unit.

(iii) Very often left a sergeant behind during training to find out if the next man could take over.

(iv) During training and especially in bridging camp my whistle blew and I named "dead men" and finished many a bridge with my only officer and all N.C.Os. sitting on the bank watching for likely good sappers for stripes. It produced "realism" and found young N.C.Os. at the same time.

The last point brings me to what I stated earlier "let him show himself" to you. I'll explain briefly.

Pangbourne Camp 1923—all officers and N.C.Os., except possibly the odd lance-corporal "dead"—fifteen-minute break on the bank—practising "form cut," but bridge "through," expecting *Queen of the Thames* pleasure steamer any moment—subalterns, C.S.M. and others a bit worried—*Queen* rounds corner. *Queen* hoots loudly. *Queen* hoots very loudly—all ranks very anxious, myself being exceedingly foolish risking heavy Government compensation and damage to W.D. property and a severe reprimand—I had confidence in my men. Eventually I blew my whistle and gave the order "All dead men remain dead—FORM CUT." There was a gasp of astonishment, but I have never seen men move quicker in my life or keener—obviously proud of my confidence in them and determined to let no one down.

I said to my subaltern and senior sergeants "go and look for lance-corporals" and went myself.

There was a hitch—a nasty hitch with a cable—slight argument arose—I got nervous but suddenly two sappers completely took charge and the job was over by seconds and accompanied by cheers from the trippers, but the megaphone of the skipper appeared to convey a different appreciation of the situation.

I believe one of those sappers is now R.S.M. (P.S.I.) to T.A. in the North and the other a Major (Q.M.).

To sum up, even with a superfluity of N.C.Os. one can by devious means still create situations which will allow the youngster in the ranks to show he has got the essential qualities there—confidence, power of taking charge and a sense of responsibility.

Too Few N.C.Os.

In 1935 I was commanding the 55 Field Company in Catterick. It was my second training season and I had what I considered a good unit. I felt I could take them to war with confidence and that we would carry out our task whatever it might be. Then the blow fell. Mussolini became "foolish" in North Africa. My Field Company was the only one not fully mechanized and I got orders to send some sixty N.C.Os. and men to a Field Company in Southern Command to make them up to strength to go overseas.

I was allowed to keep the C.S.M., C.Q.M.S., troop sergeant and also the odd pay corporal, as I was in the process of mechanization and changing my equipment and "mob store." I considered I should have been treated as a "cadre," as were the infantry units in the station, but to my astonishment I was told by my C.R.E. that nothing was further from his thoughts—I would proceed almost at once to Ravensworth Castle for the Northern Command Tattoo with a T.A. Army Troops Company under my command.

It was, however, drummed into me that I would use them as a unit on specified jobs and *not* employ any of their officers and N.C.Os. to assist me in administration. I must now state that I had during my previous two winter training seasons taken full advantage of all Chatham courses for senior and junior N.C.Os. and had just told Records, who were so hard up then for junior N.C.Os., that I really had no more Sappers to recommend for promotion—in fact I had reached "bottom"—what a laugh they had at me later and I laughed too.

I proceeded to Ravensworth Castle with my "squad" of about twenty all ranks—I had to leave a few men in my barracks at Catterick. On arrival I found that I had the following jobs :—

1. Supervision of erection of stands by contractors.
2. Ten trestle bridges, foot and car.

3. 200–250 notices of all sizes which expanded to nearer 500—the correct wording and correct siting were the real problems.

4. Dozens of usual offices—gents and women. (By the way "women" *not* "ladies" as the latter in Yorkshire can be read "laddies" and confusion results.)

5. Maintenance of Viking ships, small tanks, castle walls—all made lightly to save money and damages nightly were part of the game—the "castle" went up in one to two minutes. Also lights, waves, P.T. gear *ad lib*, etc.

Now remember I could not use the T.A. unit N.C.Os. and certainly was busy enough myself so I had to choose the best sappers I had left—gave them unpaid stripes and said "Report every morning to the Tattoo Secretary for orders and/or to the T.A. Major."

What chests they threw. Notices grew like mushrooms, 100–200, 300–400. One lance-corporal painter (unpaid) and one carpenter organized this—notices made by T.A. unit: positions altered frequently. Tanks and ships broke just before the performance in spite of morning repairs.

Everything that could go wrong went wrong, in small details and sometimes large ones—a large wooden cross over the castle tower with hundreds of lights failed to rise and light up just before the appointed time—it was only a few seconds late in the end.

Nothing failed as far as I can remember in any performance. Moments of anguish were many, but my unpaid N.C.Os. never failed to produce the goods, a bright idea or some valuable store, at the last or correct moment.

I can remember a small tank propelled by two push bikes, "out of action" just before it should have gone into the arena—two minutes before time one of my unpaid lads arrived with two new bicycle chains—he had heard about it—taken a motor cycle (W.D.), no licence and no permission (no time)—knocked up a bicycle shop returned with the necessary stores—on tick.

I'll say no more—I would not have asked for my old N.C.Os. back—it was a pleasure watching them develop in the six to eight weeks. When I returned to Catterick I recommended four sappers for lance-corporal roster and gave them the best "chits" I had ever given. Records smiled nicely on paper and I smiled with them.

Someone will now say—"Yes all very well, but you have not solved our problem of how to train them, even if you have helped us a little to find them."

But haven't I—think it all out carefully. The underlying lesson is that you create the situation in the first instance to let them "show themselves to you" and then the fewer N.C.Os. you have the easier it is to give them responsibility which will train them. It is not all done on the square by any means.

STABILITY OF BUILDINGS

By Major P. H. Glibbery, M.I.Mech.E., A.M.I.M.M.
(Late R.E.)

THE stability of any building is attained by successfully combining the construction of a well designed superstructure with an equally well planned substructure or foundation. It is accordingly most essential, that the design and constructional details for any intended building are accurately determined for fulfilling their respective functions, technically, in conformity with site conditions, and to suit local requirements.

The purpose of this article is to describe how certain features of design and construction, as adopted in an actual building, produced detrimental reactions upon the stability of the whole structure, and also to give the remedial measures employed for restoring the building to a reasonable state of security.

The structure concerned was a single-storey steel-framed building, 500 ft. long by 140 ft. wide, of type and construction as indicated in the accompanying Figs. A and B. The central supporting columns for the main transverse roofing girders consisted of a row of 10 by 6 in. rolled steel joist stanchions, spaced at 25-ft. intervals along the longitudinal centre line of the building. These stanchions were each mounted on a 4 ft. square by 6 ft. deep concrete block foundation. The floor of the building was composed of 6 in. thick concrete reinforced with steel mesh fabric.

Since its construction in 1938–9, the building had been constantly used for bulk storage purposes and the intensity of floor loading had normally been 8 to 10 cwt. per sq. ft. During the last war period, however, due to abnormally high stacking of stores, the normal floor loading was increased by approximately twenty-five to thirty per cent.

It will be observed from the accompanying sketch that a 6-in. glazed-ware surface water drain was embedded under the floor, for the collection and disposal of all rainwater discharged from the down pipes which were connected to all the central stanchions. This drain extended the full length of the building, passing adjacent to the foundations of the stanchions, and was laid with gradients to fall from the centre of the building for discharge into a manhole at each end of the building, the manholes being directly connected to the surface water main drainage system.

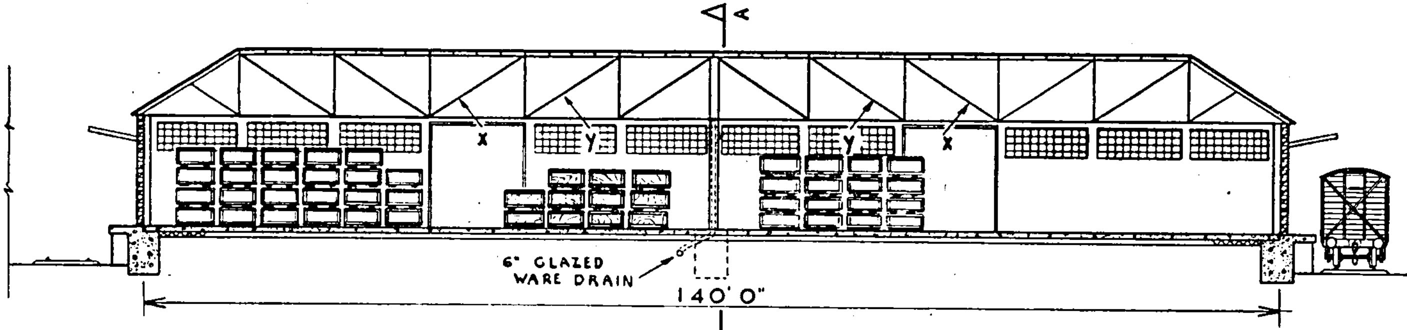
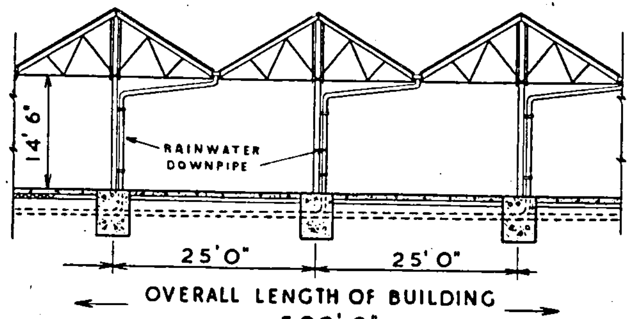


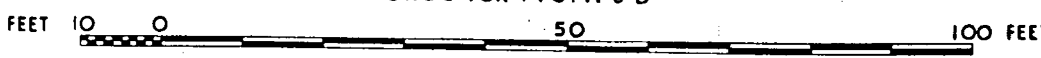
FIG. A



SECTION AT A—A

FIG. B

SCALE FOR FIG. A & B



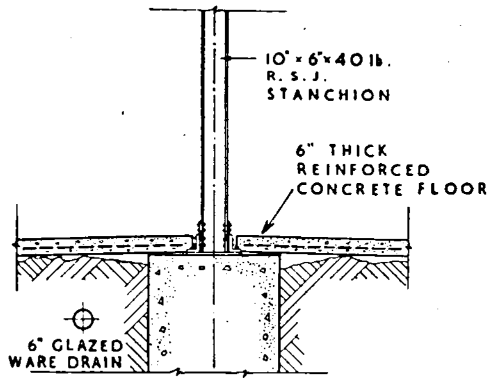


FIG. C

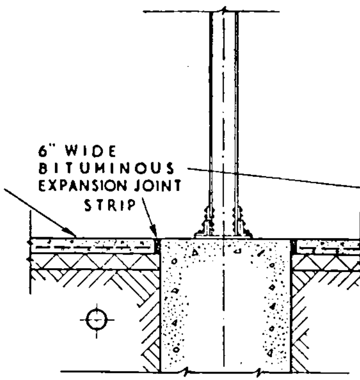


FIG. D

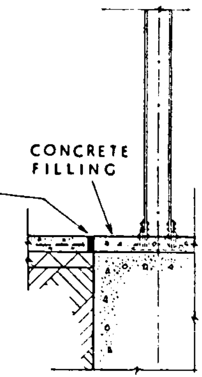


FIG. E

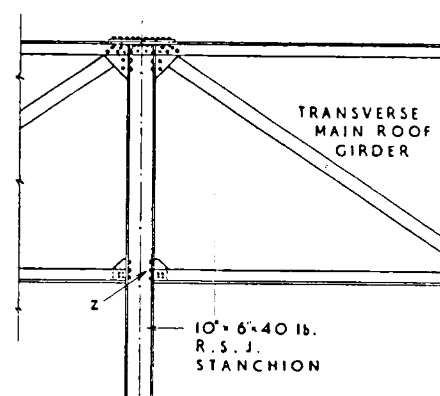


FIG. F

The foregoing description of the building, together with Figs. A and B in the accompanying sketch, should enable the reader to visualize its general layout and construction and readily to understand the following details, which give the findings recorded during the investigations into the causes and effects of the failures.

During the preliminary examination it was noted that large areas of floor throughout the whole length of the centre section of the building, which supported the stock piles of stores, had subsided, together with all the central stanchions. Additionally, it was observed that in all the main transverse roof girders, the diagonal tension members marked " x " in Fig. A were buckled at least four inches out of correct alignment, and in some instances the diagonals marked " y " were also similarly affected, but to a lesser extent. It was obvious that the " bowing " of these diagonal members was due to distortion of the main roof girders caused by the subsidence of the central supporting columns. The magnitude of the subsidence was later determined, and it was discovered that the central stanchions had all sunk in varying amounts ranging from approximately three to six inches, and that the floor had subsided three to four inches in excess of that of the nearest stanchion foundation.

The effect of this was that the concrete floor sloped downwards in all directions away from the stanchion foundations as indicated in Fig. C, and from which it should be particularly noted that the concrete floor was constructed to rest directly upon the tops of the stanchion concrete bases, a feature which will be referred to later.

The first operation for investigating conditions under the floor was to remove areas of sunken floor adjacent to the central stanchion foundations, and over the surface water drain. Briefly, the faults revealed large cavities beneath the floor and the earth sub-base was very moist. The reasons for this were soon established when the surface water drain under the floor was exposed. The drain was found crushed in numerous parts throughout its length, due, beyond doubt, to the sunken floor, and had been rendered entirely useless. It will readily be appreciated that with the under-floor drainage system not functioning, no outlet remained for the surface water discharged from the stanchion rainwater down pipes, except by seepage through the ground beneath the floor. This consisted of ordinary clayey loam and sand mixed with clay earth filling, and it was ascertained that the filling was approximately four feet deep. It was visualized that during heavy rainfall, the cavities under the floor became waterlogged, and the earth filling generally saturated. The formation of the cavities had undoubtedly been a gradual process since the drain first became broken. This condition was aggravated by the fact that as the central stanchions had sunk, the roof valley rainwater gutters, which had similarly been thrown out of vertical alignment, discharged more rainwater into the central stanchion down pipes than was originally intended.

The infiltrating rainwater under the floor produced the effects of considerably reducing the bearing value of the floor sub-base and that of the subsoil, together with the shrinkage of the earth filling under the floor, and the ultimate undermining of the stanchion foundations, with detrimental results to their stability.

These under-floor conditions were thus established as being the primary causes of the failure of the structure generally. Their direct effect upon the central stanchion foundations and how they in turn caused distortion in the roofing framework will now be analysed. Fig. C indicates the general condition of floor and its sub-base as found at the stanchion bases, with the concrete floor, as already mentioned, sloping downwards in all directions from the tops of the stanchion foundations. With piles of stores usually stacked within fifteen to eighteen inches from the sides of the stanchions, it followed, owing to the impaired condition of the floor sub-base, and with the floor resting upon the tops of the stanchion foundations, that these foundations became localized supports for withstanding near-by floor loading, thereby exerting considerably more pressure on them than was intended for their normal loading, i.e., that imposed by the weight of the superstructure. This excessive loading was undoubtedly the main contributory factor causing the gradual sinking of the stanchion foundations in subsoil which, for reasons already given, had lost considerable bearing value. The subsidence of these foundations, together with the stanchions they supported, provided the reasons for the distortion in the main superstructure.

A ground survey of the site indicated that all the stanchion bases throughout the building were mounted on shallow excavated virgin soil.

Two "drop-weight" tests were, therefore, made to obtain an approximate bearing value of the virgin subsoil in shallow excavated ground on the building site at an equivalent level to that represented by the base of the stanchion foundations. Allowing a factor of safety of 8, the bearing value of the virgin subsoil, which consisted of a formation of clay with a mixture of sand and clay, was computed from the tests to average approximately 1.75 tons per sq. ft.

It was accordingly concluded that the subsoil, under normal conditions, was capable of easily withstanding all correctly disposed loading transmitted from the superstructure to its supporting foundations.

All apparent causes of failures and their combined detrimental effects upon the building structure, and the nature and normal bearing value of the virgin subsoil having been determined, the remedies to be employed, were next considered.

It was decided first to rectify the faults in the substructure, for the primary causes of the trouble were at and beneath floor level ; and then to concentrate upon relieving the over-stressed main roof girders, and correcting their alignment within practical limits by the most economical means, to ensure their future safety. All badly sunken areas of floor were broken up with pneumatic road-breaker tools and the surface water drain under the floor was exposed throughout the length of the building. Concurrently, the areas of floor resting upon the central stanchion foundations were cut away clear of these foundations, to ensure the complete isolation of the latter and freedom from any future floor loading.

The surface water drain was renewed with new 6-in glazed-ware piping and adequately encased in a concrete surround, and with new branch connexions fitted to the stanchion rainwater down pipes. The earth filling under the floor was reconsolidated and superimposed with a hardcore floor sub-base, formed from the previously broken-up concrete floor and rubble, etc.

The floor was then renewed to correct level, as in Fig. E, except those areas which previously rested upon the stanchion foundations, and which are indicated in Fig. E as concrete fillings. This making good of the areas above the stanchion foundations will be referred to later conjointly with Fig. D.

All faults in the substructure having been corrected, attention was then concentrated upon the thirty-eight distorted main transverse roofing girders to determine how these could best be rectified at least expense. This at first sight appeared a rather formidable proposition, particularly as it was obvious that indeterminate stresses existed in the various component members of these girders, necessitating precautionary measures being taken before any work on the girders could be commenced.

For example, the angle cleats at joint " z " shown in Fig. F, were in some instances found to be bent along the line of their connecting bolts to the stanchion flanges. This furnished proof that considerable tension existed at the joint, whereas normally no such stress should occur.

It was decided, in the first instance, to experiment with one of the worst distorted roof girders in an endeavour to establish a suitable method for its reinstatement to normally stressed conditions, without raising the whole of the section of roofing structure which it supported to its originally constructed level.

It will be observed from Fig. A that the main roof girders are of the N type, sometimes referred to as Linville design, and in which all the diagonal members are incorporated to resist tensile stress only. The buckled or " bowed " diagonals " x " and " y " in Fig. A to which reference has already been made, could not possibly be functioning as tension members, for which they were designed, whilst in their present distorted condition. The problem was how these diagonal members could best be straightened and reinstated to perform their normal functions. The members, being fixed at their ends with riveted connexions at the top and bottom chords of the girders, could not easily be removed. With this in mind, and various other technical and structural considerations having been taken into account, it was decided to take the following action for trial purposes on the first girder selected.

Two steel, tubular, framed scaffolds were assembled with suitable horizontal cross braces at the top so that timber packings could be inserted between these and the underside of the bottom chord of the roof girders. The top faces of the packings were fitted with mild steel flat bars and greased to ensure free movement between the packings and the roofing girder in a longitudinal horizontal direction, should such movement of the girder take place, and which was necessary for the girder to adjust itself during the following operations. The two scaffolds were approximately 14 ft. high, 10 ft. long by 5 ft. wide at base tapering to 3 ft. wide at top, and were each fitted with a plank working platform at the top at approximately the same level as the bottom chord of the roof girder. The scaffolds were wedged up into position, one under the end of the roof girder adjacent to the central building stanchion to which it was connected, and the other under the panel of the same girder where diagonal " x " occurred. The timber packings already mentioned were then inserted and wedged to form a tight joint between the scaffolds and the underside of the girder. This was a precautionary measure for protection against any mishap which might possibly occur during the next step in the operation, which involved dismantling the bolted connexion at " z " in Fig. F, consisting of six $\frac{3}{4}$-in. diameter bolts, between the bottom chord of the girder and the flange of its supporting stanchion. As these bolts were very gradually slackened, a close watch was kept to detect any possible effect upon the main girder.

The following very significant reactions immediately occurred. The distorted members " x " and " y " commenced to straighten, and the bottom chord of the girder lifted itself clear of the packings underneath. When the bolts had been slackened off approximately $\frac{1}{2}$ in. they became practically free, and by then member " y " had straightened itself to correct alignment, and the bottom chord of the girder had risen approximately $\frac{3}{4}$ in. clear of the temporary supporting packings at " x " diagonal panel. " Bowing " of diagonal " x " was appreciably reduced in consequence of the operation, but as some " bowing " still remained in this member, it had to be further considered. In the meantime, a mild steel packing was inserted to make the joint good where the bolts had been slackened off and the bolts were then tightened up. The straightening of diagonal " x " was then dealt with in the following manner. Two screw-type adjustable tubular scaffold tubes were inserted between the underside of the girder and floor at points immediately below the two vertical members at each end of diagonal " x " and tightened up as much as possible and this produced about $\frac{1}{4}$ in. lift on the girder at panel " x." A further additional half turn of the nuts, by special long wrench, on the connexion bolts between the bottom chord of girder and stanchion at " x " in Fig. F was then made to ensure absolute tightness of this joint. Diagonal " x " which consisted of two $2\frac{1}{2} \times \frac{5}{16}$ in. mild steel flat bars, was then cut through at one point with an oxy-acetylene cutting flame. This enabled the two bars automatically to straighten out independently of each other and the laps thereby formed by the bars, where the cuts were made, provided an easy means for making two sound lap-welded joints. The temporary adjustable tubular scaffold tubes inserted as struts underneath the girder were then removed and the nuts of the bolts at the bottom chord connexion were slackened by about one half turn to restore to normal tightness. The combination of these two operations ensured that diagonal " x " now correctly functioned as a tension member.

The whole process on this one girder having been successful, the two temporary tubular scaffolds were dismantled and converted into two mobile scaffolds each mounted on four wheels. All the remaining main roof girders in the building then received similar treatment to that applied to the one described above, with equally successful results, and thus its stability for the future was reasonably assured.

The tops of the central stanchion foundations, were subsequently made good with concrete filling to floor level as shown in Fig. E. It should be noted that they were purposely isolated from the concrete floor by means of 6 in. wide bituminous expansion joint strips. The concrete fillings above the stanchion foundations were not poured previously as free access to all stanchion holding down bolts was considered desirable until rectification of the building superstructure had been completed.

In conclusion, it appears opportune to remark that had the stanchion foundations been originally designed and constructed in the manner as indicated in Fig. D, the sinking of the floor could not possibly have had any direct adverse action upon the superstructure, and the distortion to the roof structure would probably have never occurred. The troubles arising from the sunken floor would most likely have been confined to the floor substructure.

MEMOIRS

MAJOR-GENERAL S. G. LOCH, C.B., C.S.I., D.S.O., D.L.

STEWART GORDON LOCH, who died at his home at Pertenhall near Bedford, on 27th March, 1952, was born in India on 13th April, 1873, the son of the late Captain R. G. Loch, 20th Hussars and Indian Staff Corps. Educated at Westward Ho !, Merchant Taylors and the R.M.A., where he was a U.O. and in the XV, he was commissioned in the Royal Engineers in February, 1893. After courses at the S.M.E. he went to India, where he spent nearly all his service.

He joined the Queen's Own Sappers and Miners in 1895, and remained with them for nine years. He thoroughly enjoyed his service with the Madras Sappers and the polo, shooting and racing in various parts of India and in Burma with the 4th Company stationed there. In 1900 he commanded a Telegraph Section of the Corps in the expedition sent to deal with the Boxer rebellion in China. After a further spell at Bangalore he left the Madras Sappers in 1904 to go to Military Works in Rawalpindi. This was Loch's last service as a Sapper, as the following year he passed into the newly opened Indian Staff College and was thereafter continuously employed on the staff and in command until his retirement.

After second grade "Q" and "G" appointments at Army Headquarters in Simla, Loch became in 1911, Brigade Major of the Dehra Dun Brigade, gaining a brevet majority in the following year.

In 1913 as G.S.O. II of the Bannu Brigade area he continued to acquire knowledge of the North West Frontier at first hand. Later it was said of him by Lord Birdwood that he was the only officer he knew who could talk of the frontier from end to end without a map.

In 1914 Loch arrived in England in early August on ninety days leave. He spent many hours at the War Office trying to get employment in the B.E.F., but was told he could not be spared from the North West Frontier and had to return to India ten days later. At the end of that year he returned to A.H.Q., India, as a G.S.O. I. In 1916 he was appointed B.G.G.S. Northern Command, while a substantive Major, and the following year he was given brevet promotions to Lieut.-Colonel and Colonel and substantive promotion to the latter rank.

Of this period G.G.S. writes : "As G.S.O. III, I served for a few months under General Loch, who was then B.G.G.S. Northern Command, India. The General Staff there had long been the preserve of Indian Army officers, whose mental outlook and methods had not kept pace with the rapid progress of the 1914–18 war years.

The change when General Loch became B.G.G.S. was immediate and impressive. His brisk, cheerful efficiency, up-to-date outlook and methods, wide knowledge and experience, and above all his determination to serve the best interests of the troops, soon impressed a new spirit into the headquarters.

"A personal incident may illustrate. My work was mainly concerned with intelligence of the North West Frontier, which I had never seen, having been in France and Belgium during the 1914–18 war. I asked to be allowed to visit the frontier to learn something of the ground, places, troops and tribesmen. The B.G.G.S. at the time indignantly refused saying that only Army Commanders went on tour. The request repeated soon after General Loch's arrival was not only at once granted, but warmly welcomed, and accompanied by advice for my tour arrangements."

During his tour as B.G.G.S., Loch had to contend with a good deal of trouble on the frontier, including the Third Afghan War. He constantly tried to serve there himself, but it was not until 1920 that he was given command of the 5th Indian Infantry Brigade in the Kohat District: this was followed by the command of the Nowshera Brigade from 1922 to 1925. He was promoted Major-General on completion of his tenure and retired towards the end of 1926. This was not the end of his connexion with India, as he later was delighted to become Colonel of the Madras Sappers and Miners.

In 1929 Loch settled at Pertenhall in the north of Bedfordshire, where he lived an active life until two years before his death. Spare time occupations included shooting, beagling, tennis and gardening, but most of his time and energies were devoted to the British Legion, the Territorial Army Association, the St. John Ambulance Brigade, etc., and in 1940 onwards to the Home Guard and the National Savings Association. He became a Deputy Lieutenant of Bedfordshire and was made an Officer (Brother) of the Order of St. John of Jerusalem. In 1950 he became dangerously ill and was not expected to live. Though he made a remarkable recovery he was not again able to resume his active life: he bore the adversities of illness and inactivity with great patience.

First as Chairman for Bedfordshire County British Legion for fifteen years, and Vice-President of the Eastern Area, and later as President of the County, General Loch's keen interest continued till the end, though forced by illness a few months earlier to resign. Lord Luke, who succeeded him as County Chairman and later as President writes: "The County Honorary Secretary, has a vivid memory of taking Certificates of Appreciation for his signature only a very short time before the General's death. The fact that the Legion members had specifically asked for General Loch's signature on the Certificates, even though no longer President, speaks volumes for the esteem in which the General was held by Legionaires. No fitter tribute could be paid to his memory and to his untiring and active interest in the Legion."

Of those who knew him, H.J.W. writes: "Stewart, 'Sapper' Loch to his many friends, came of a line of soldiers and in him crystallized their military qualities. He was a born leader and commander, his mathematical mind giving him the precious qualities of accurate thinking and concise expression. His outstanding personal characteristic was cheeriness, so valuable in a commander since it can irradiate amongst his staff and command and keep them going equally cheerfully however adverse the circumstances."

G.A.B. writes: "Major-General Loch, then aged 67, joined the Home Guard on its original formation in May, 1940, as a private and was shortly afterwards appointed platoon commander with the rank of Lieutenant. Later the 65-year age rule forced him to relinquish his commission, but he at once re-joined as a private and was promoted Sergeant and continued to serve in that rank until the Home Guard was disbanded. By his public-spirited example he gave a great impetus to recruiting in the Home Guard in that part of Bedfordshire in which he resided."

Stewart Loch, had few material advantages to help him in his career, but he inherited and developed a strong personality, which owed more to hard work, common sense and spiritual strength than to anything else. Completely unselfish and unself-seeking, he was ambitious only to improve—so far as lay in his power—the efficiency of the Army. He was a trusted subordinate, an outstanding trainer of troops, and a born leader. In his home life, which was very happy, he was a delightful host: austere and simple by taste, he gave of his best to his friends. Those who were in trouble were always sure of his ready help often given at some cost to his own health. An embodiment of many of the virtues of his Scottish ancestry, he was an upright man and a humble Christian.

H.E.F.R.

Major-General SG Loch CB CSI DSO DL

Major-General WH Beach CB CMG DSO

MAJOR-GENERAL W. H. BEACH, C.B., C.M.G., D.S.O.

WILLIAM HENRY BEACH, affectionately and universally known throughout the Army as Bill Beach, died on 22nd July, 1952.

He was the younger son of the late Canon W. R. Beach, C.F., and was born on 7th June, 1871. He passed through the Shop and was gazetted 2nd Lieutenant in the Royal Engineers on 27th July, 1889. After leaving Chatham he served at the Curragh and in Cairo and then went to India in 1895, where he spent most of his service.

He spent about three years in the Military Works Service and in the Irrigation Branch of the P.W.D., and was then transferred (in 1899) to the Bengal Sappers and Miners, with whom he served until 1905, commanding successively the 6th and 5th Field Companies. He then left the Sappers and Miners to take up the appointment of Brigade Major of the Meerut Cavalry Brigade, after which he became Brigade Major of the Dehra Dun Infantry Brigade. He saw his first active service in the Mohmand Expedition of 1908.

In 1912 he was appointed to the staff of the Southern Command as A.M.S. to General Sir John Nixon, whom he accompanied to Mesopotamia in 1915 as head of the Intelligence Branch of Indian Expeditionary Force " D." An officer who served under him writes : " I never heard one word of criticism or indeed of anything but real affection for Bill from any one of us and we were a mixed lot . . . Bill and the ' I ' Branch, entirely organized by him, had a reputation for infallibility not always attained by directors of intelligence." His experiences in this appointment included receiving a gunshot wound in the arm at the Battle of Ctesiphon, and negotiating with the Turkish High Command the surrender of the garrison of Kut, a subject which he refused ever to discuss. After the end of the Mesopotamian Campaign, he headed the Intelligence Mission to the Caucasus, where he remained till 1919.

After World War I he became Deputy Director of Intelligence at A.H.Q. India, which appointment he held till 1923 when he was given command of the Jubbulpore Brigade. He held this until 1927 when he reverted to England on half-pay, being promoted Major-General on 30th January, 1928. In 1929 he was appointed to the Command of the 42nd Division T.A. until his retirement in 1933. He was appointed a Colonel Commandant R.E. on 27th February, 1936. Such is the bare outline of a career as varied as ever fell to the lot of an officer of our Corps.

Bill Beach was, above all, a very human man. His troops and subordinate officers all loved him : they were always ready to do anything for him and he had a capacity for command not enjoyed by many of his contemporaries. He knew his Indian Sappers intimately and they recognized his ability and thoroughness and, above all, his fairness and readiness to help any man in trouble.

When commanding the Jubbulpore Brigade, he got to know every officer, many of the British N.C.Os. and most of the Indian officers by name. All ranks revered him, not only as a commander, but as a good friend who joined in all their sports and games. When the time came to relinquish his command the whole Brigade turned out to a man to line the railway line so that each man could give his own parting cheer as the train passed him on its way towards Bombay.

His command of the 42nd Division was an equally happy one. He knew every officer by name and, in many cases, by his nickname. It was a thousand pities that his age precluded him from reaching the rank of Lieutenant-General, as he would have made an ideal Director-General of the Territorial Army.

Thorough and successful as he was as a soldier, he was also a keen sportsman. In India he indulged his fancy to the full in polo, pig-sticking and shooting, especially of small game. After returning to England, he played regimental golf with success and was a member of the Corps winning teams against the Gunners and the Brigade of Guards in 1920.

After retirement he became Chairman of the R.E.O.C.A. where he found full scope for his energy, sympathy and his love of doing things to help others who were less fortunately situated than himself. On his retirement from the Chairmanship he was granted the unique honour of being appointed Vice-Patron of the Association.

Amongst his honours and awards he was given the brevets of Lieut.-Colonel and Colonel during World War I: he gained the D.S.O. (1916), the C.M.G. (1917) and C.B. in 1919. He was A.D.C. to the King from 1922 to 1928, and wore the War Medals for the N.W. Frontier of India (1908), the 1915 Star, the Victory and War Medals for World War I: he was granted the Serbian Order of Kara George in 1916, and, subsequently, King George V's Jubilee Medal and King George VI's Coronation Medal. He was seven times Mentioned in Despatches.

General Beach married, in 1914, Constance Maude, daughter of the late Captain A. A. Cammell, 14th Hussars, and he leaves one son, Captain W. G. H. Beach, M.C., who has already made his mark in the Corps.

It is impossible to cover in such a short space a full account of Bill Beach's wonderful and varied career. As already stated, he was essentially human; he had a keen sense of humour and set a very high standard in his work, as in his play. He was loved by all and had no enemies. His many friends are the poorer by the passing of one of the leading soldiers of his day as well as a gallant and a very great gentleman.

J.R.E.C.

LIEUT.-COLONEL SIR JOHN R. CHANCELLOR, G.C.M.G., G.C.V.O., G.B.E., D.S.O.

LIEUT.-COLONEL SIR JOHN ROBERT CHANCELLOR, who died on 31st July, 1952, at the age of 81, was the youngest of the brilliant team of R.E. overseas Governors of the early part of the century, which included Lord Sydenham (Sir George Sydenham Clarke), Sir Henry McCallum, Sir Herbert Chermside, Sir Ronald Macdonald, Sir Matthew Nathan, Sir Percy Girouard, Sir Gordon Guggisberg, Sir John Clauson and Sir Samuel Wilson.

Born in Midlothian on 20th October, 1870, the second son of Mr. C. E. Chancellor of Woodhall House, he passed from Blairlodge School, Stirlingshire, straight into Woolwich, and in 1890 was gazetted into the Corps, fourth of a batch of which the late Sir Humphrey Leggatt was the head. After special training in railway work in 1895 he went to India and, joining the Sappers and Miners, was fortunate enough to go on service with the Indian Contingent in the Dongola (Nile) Expedition in 1896, and in 1897–8 to be in command of the Sirmur Imperial Service Sappers in the Tirah Expedition, when he was Mentioned in Despatches and awarded the D.S.O. for his services. Returning home to Chatham in 1900, he gained one of the two vacancies at the Staff College offered each year in those days to the officers of the Corps.

On graduating, Chancellor was at once posted to the Intelligence Division, then under General Sir William (later Lord) Nicholson. Next year, on the formation of the Committee of Imperial Defence, with Colonel Sir George Sydenham Clarke, R.E., as Secretary, Chancellor was selected for the appointment of Assistant Military Secretary, and in 1906 to be Secretary of the Colonial (now Overseas) Defence Committee. In these capacities he impressed both Conservative and Liberal Ministers with whom he came in contact by his zeal and far-ranging abilities, and in 1909 was awarded a C.M.G. But it was entirely " out of the blue " that in 1911 he was offered the Governorship of Mauritius. He was 40, had been promoted major only in the previous year, and not having served in the South African war of 1899–1902 his prospects in the Army were not very bright. He therefore accepted, and in 1913 was knighted as a K.C.M.G. When war came in 1914, he was heart-broken that the Cabinet would not allow him to return to the Army.

He remained in Mauritius until 1916, being then transferred to Trinidad, where he stayed the full five years. Returning to England in July, 1921, he was appointed Principal Assistant Secretary of the Committee of Imperial Defence where he remained until September, 1923, when he was sent, having been promoted to G.C.M.G. in 1922, as the first Governor to Southern Rhodesia for another five years. There as *The Times* said : "As a Royal Engineer his opinion, always shrewd and practical, was valued in regard to various works which the young colony was then considering and commencing." In 1925 he was created a G.C.V.O.

He had now had seventeen years experience of Governorship ; his administrations had been marked by his fairness, his firmness and his good judgement, coupled with sympathy and understanding. It therefore seemed in every way appropriate when the situation in Palestine required skilful handling that he should be selected in November, 1928, to go there as High Commissioner and Commander-in-Chief, being then appointed a Knight of Grace of the Order of St. John of Jerusalem.

Chancellor's three years of office in Palestine were, as expected, troubled. Officially he had to support the Jews, but his sympathies, as were those of most British residents, were with the Arabs, who had been established there for over 1,100 years. He was actually on leave in 1929 when, following on provocative incidents at the Wailing Wall, murderous attacks were made by the Arabs on the Jews ; but the mere fact that they had occurred seemed to him to be a reflection on his administration, and deprived him of the personal satisfaction which he had enjoyed in his previous Governorships.

On his reaching 60 years of age he was placed on the retired list. At a farewell reception given by the Mayor of Jerusalem he said : "I came hoping to increase the country's prosperity and happiness, I am leaving with my ambition unfulfilled. Conditions were against me."

He still had twenty years of life before him, and they were far from idle ones. He became Vice-Chairman and member of the Executive Committee of the British Council ; member of Council, Vice-President and Foreign Secretary of the Royal Geographical Society ; Vice-President of the Royal Empire Society ; and between 1933 and 1945 was Chairman of five Government committees, and of the International Committee on Locusts. He was also a Member of Council of the Royal African Society and of the International Colonial Institute, and held a number of directorships of commercial companies with colonial interests. For his services to the Ministry of Agriculture and to British agriculture as Chairman of the Permanent Joint Hops Committee and of the Agricultural Marketing Facilities and Livestock Committees, he was, in 1947, created a G.B.E.

All his life he was a very hard worker. Although in his early days he used to shoot and fish, he played no games, and never at any time had any hobbies. He illustrated the old adage, which is so true, that no man is really happy until he finds his pleasures in his work. Sir Thomas Lloyd, Permanent Under-Secretary of State for the

Lieut-Colonel Sir John R Chancellor GCMG, GCVO,GBE,DSO

Brigadier-General RBD Blakeney CMG DSO

Colonies in a letter to the *Sunday Times* spoke of Chancellor's "unrivalled record at the time as a Colonial Governor." He did indeed possess the knowledge, and exhibit all the qualities desirable in such a post. In Mauritius and Trinidad he is still spoken of with affection and respect; Southern Rhodesia has honoured him by placing his portrait in the new Parliament buildings.

He is survived by his widow, whom he married in 1903, a daughter and two sons, one of whom, Sir Christopher Chancellor, is general manager of Reuter's.

J.E.E.

BRIGADIER-GENERAL R. B. D. BLAKENEY, C.M.G., D.S.O.

ROBERT BYRON DRURY BLAKENEY was born on the 18th April, 1872, the son of William Blakeney, R.N., of Westward Ho! He was gazetted 2nd Lieutenant, R.E., on the 24th July, 1891, and, after the usual course at the S.M.E., was posted to the Balloon Section at Aldershot in 1893. Three years later he was selected for service with the Dongola Expedition in Egypt.

Blakeney was one of that small band of R.E. subalterns who, between 1896 and 1898, under the orders of General Sir Herbert Kitchener and with the drive of Lieutenant E. P. C. Girouard, R.E., built the railway from Wadi Halfa up the Nile to Dongola and later the desert railway to Abu Hamed and Berber and then on to Fort Atbara, at the junction of the Nile and Atbara Rivers, and thus made possible the defeat of the Khalifa at Omdurman on 2nd September, 1898.

Blakeney arrived from Suakin at railhead, at Atkasha, about seventy-five miles south of Wadi Halfa, in June, 1896, but was at once put in quarantine for cholera, and was not available for work on the railway for about a month. At that time there was a considerable amount of confusion. Kitchener had planned to advance with his army and gunboats and capture the Dongola province as soon as the railhead reached Kosha, a further thirty miles. To get gunboats forward, it was essential for the move to take place at high level of the Nile. Lieutenant R. Polwhele, R.E., who had trained the Egyptian Railway Battalion to lay the line at the rate of one mile a day, had died of enteric. Cholera had also broken out and accounted for two other British officers. To add further to the troubles there were widespread washouts between Wadi Halfa and the railhead, and Girouard had been struck down by sunstroke.

In spite of these difficulties, however, the railway was pushed on and reached Kosha on 4th August. Further floods caused extensive damage to the line and Kitchener himself took a personal hand in directing repair work. The line was restored to running order by

6th September and the army was able to advance and win the battle of Hafir and occupy Dongola.

After the battle of Hafir, Blakeney was employed on extending the railway to Kerma, a distance of about a hundred miles, which was reached in May, 1897. Immediately on completion of this line the whole staff was moved to build the new desert line from Wadi Halfa to Abu Hamed, a distance of 230 miles, which was reached in October, 1897. Blakeney played a prominent part in the construction of this line. Space does not permit of details of the work which is well described in Sandes's *Royal Engineers in Egypt and the Sudan*. The railway was then extended to Berber and Fort Atbara, a further 155 miles, which was reached in July, 1898. In September the battle of Omdurman was won and Khartoum captured. Blakeney was present at the battle as Galloper to Brigadier-General Lewis. He was awarded the D.S.O. for his services in the campaign.

After this campaign Blakeney continued working on the Sudan Railways and became Traffic Manager, but in May, 1899, Girouard got him transferred to the Traffic Department at Cairo, where he remained till January, 1900, when he was posted to command the 3rd Balloon Section, R.E., in South Africa. Balloons with oxen to drag them were not of much use in locating the mobile Boers, although they did materially assist by giving artillery observation during the advance for the relief of Mafeking, and shortly afterwards the Balloon Section was broken up. Blakeney then became Assistant Director of Railways at Lorenzo Marquez.

In 1901 he returned to the Traffic Department of the Egyptian Railways, becoming Deputy General Manager in 1906 and General Manager 1921–3. Meanwhile he had been promoted Major under the twenty years rule, and had retired from the Army in February, 1914.

During the first World War, he was D.D.R.T. and in 1919 Director of Railway Traffic in Egypt, with the rank of Brigadier-General, and rendered great assistance to the Army in the working of the 627 miles of railway line laid from Kantara to the northern end of Palestine. For his services Blakeney received the C.M.G. in 1918, as well as the Legion of Honour and 2nd Class Order of the Nile. During the second World War, he did his bit as a Home Guard and in the A.R.P. and N.F.S.

Blakeney was known to all his companions as "Blank." He was a very cheerful companion and always saw the funny side of things, while at the same time he was an ardent student of spiritualism.

He died on the 13th February, 1952, at his home in Mont au Prêtre, St. Helier, Jersey.

C.G.F.
H.L.P.

BOOK REVIEWS

EAST VERSUS WEST

By Lieut.-General Sir Giffard Martel, K.C.B., K.B.E.

(Published by the Museum Press. Price 12s. 6d.)

It is exhilarating in this book to have a gallop with Martel over the obstacles which confront the Western world. But you need to be bold always to follow his lead. Woe betide you if you sometimes prefer to dodge a fearsome morass or an appalling chasm by slipping through a gate. By so doing you may easily find yourself dubbed a "yes-man," or an expert in "position warfare," or some other kind of rather ordinary person.

Everyone, however, should read *East versus West*. Most of the high-level political and military controversies, which soldiers have to study, find a place in it. Mistakes of omission and commission are so roundly condemned in so many places as to call to mind General Gruenther's recent dictum "War is a continued succession of mistakes"—a remark which applies equally well to peace.

General Martel's own contentions are not always free from error. Few readers will agree that in 1945 a satisfactory British Army could have been created by voluntary enlistment. The Socialist government, on the other hand, gave National Service a thoroughly bad start by accepting it half-heartedly. But now for the first time in peace-time for half a century and more, British Army units are full of men—Regular, Territorials, National Servicemen and "Z" Reservists are being welded into an army, which is attracting the admiration of the world.

Martel is on surer ground when he opens up on the design and handling of armour. Few men have done more than he to develop tanks for Great Britain. He is probably right in condemning the idea of the dual purpose tank and in demanding two types, one for close fighting and the other for deep penetration. Nor can it be doubted that the design and use of armour in the British Army suffered much from the absence of a powerful Inspectorate of Armoured Troops, such as that which General Guderian controlled in Germany in 1943. It is incorrect, however, to say the Germans stopped building cruiser tanks in favour of the heavier Panthers and Tigers because they recognized that "position warfare" had set in. They continued, on the contrary, to build Pz IVs. at high pressure till the end. The heavier tanks were designed to be able to give and take more punishment than any other existing design, whether in "position warfare" or any other kind of fighting.

It also seems most improbable that any Soviet forces designed to attack the West will contain any horse transport. Surely even the Russians must have had enough of that? The U.S.S.R. are far more likely to be concentrating their efforts on the production of a modern army of about seventy-five armoured and mechanized divisions. Whether they can do this successfully before the West is ready to receive them is another question.

On the political side, Martel seems to agree with Clausewitz, who said that "Russia can only be subdued by its own weakness and the effects of internal dissensions. It must be agitated to its very centre."

Some of the measures which he suggests for causing the dissensions are, however, near acts of war, especially the "Velvet Curtain" of sea blockade.

After all the fireworks on the way, the conclusions arrived at in this remarkable book are sober and practical. By stressing highlights and deep shadows like an accomplished artist, the author has produced a picture of the modern world which will undoubtedly provoke universal attention. That any profits from the sale of *East versus West* are to be devoted to Service charities is evidence of the high purpose of a fearless opponent of Communist tyranny. B.T.W.

THE CAMOUFLAGE STORY

By GEOFFREY BARKAS IN COLLABORATION WITH NATALIE BARKAS

(Published by Messrs. Cassell & Co. Ltd. Price 12s. 6d.)

One of the curiosities of the war literature of 1914–18 was a book called *Strategic Camouflage* written by the distinguished painter Solomon J. Solomon. In vivid phrase it sought to prove that the Germans had a system of camouflaging whole armies, which hidden thus, were likely to bring off the biggest surprise of the war. Although his theory happily proved to be nonsense, the book was interesting because the author conceived the enemy forward zone as a vast canvas on which camouflage concealed the real picture underneath.

Colonel Barkas, by profession a creator of the illusions of the cinema, seems to have switched his energies quite readily to the deceptions of camouflage. He started by selling the idea of camouflage to the rank and file. He ended by becoming a virtuoso in strategic camouflage, whose *chef d'œuvre* was the decisive battle of El Alamein.

As a practical man he was quick to see that camouflage cannot conceal the presence of armies, but that it can assist greatly in deceiving the enemy as to the time, strength and main direction of a big attack.

He tells his story well. His picture of Liverpool will please those who know that great sea-port. A lover of animals, he finds space for tales about a horse in Ulster and a pi-dog near Benghazi, which are rewarding to read.

Judging by *The Camouflage Story* the Corps seems to have been a bit slow off the mark at camouflage in World War II. If this surmise is true, it is a pity, for camouflage was one of the most important Sapper "war babies" of World War I. Strategic camouflage is a notable conception which must not be forgotten. This is decidedly a book to read.

B.T.W.

FROM PYRAMID TO PAGODA

By LIEUT.-COLONEL E. W. C. SANDES, D.S.O., M.C., R.E. (RETD.)

(Published by Messrs. F. J. Parsons, Ltd. Price 27s.)

From time to time the intricacies of the regimental system of the British Infantry of the Line have tempted various administrators of the Army to alter it completely. But although the old regiments, which are so famous in our history, have had to suffer indignities such as linking, "suspended animation," and occasionally even disbandment, the would-be reformers have, in the end, never ventured on any radical break with the past. The moral value of the regimental traditions has, in fact, been found always to outweigh mere administrative convenience. So the regiments happily live on, more famous than ever.

In *From Pyramid to Pagoda* Colonel Sandes, with the sure hand of an experienced historian, has added new chapters and fresh lustre to the chronicles of the old 14th Foot, now known as the West Yorkshire Regiment. The Corps will share his pride at being entrusted with such a responsible and laborious commission.

The book, well produced and provided with admirable maps, will delight not only the past and present soldiers of the regiment, but also many others who may wish to add detail and local colour to their general impressions of the recent campaigns in Africa and Burma. Your reviewer himself was thrilled to read of the events in Gallabat, Kassala and Eritrea in which the second battalion played so notable a part.

Some readers will regret that no illustrations adorn this model regimental history. The battlefield of Keren, "Dantesque: beautiful yet terrible," seems to merit one. B.T.W.

SURVEYING AND FIELD WORK (3rd Edition)

By James Williamson M.Inst.C.E.

(Constable & Company Ltd. Price 40s.)

The third edition of *Surveying and Field Work* by James Williamson, M.Inst.C.E. is based on a photographic reproduction of the previous edition. While this has prevented a general revision, opportunity has been taken by excision and replacement of sections to make some corrections and improvements.

Apart from a new chapter on hydrographic and hydro-electric surveying, the new edition covers the fundamental principles of surveying with detailed consideration given to chain, compass and sextant surveying. Further sections deal with the design and use of the theodolite, traversing, tacheometry, levelling and the adjustment of instruments. Methods of setting out works are considered, as also are methods of computing areas and volumes. Twelve trigonometric, conversion and reduction tables are included in the appendix.

Although the textbook will have an appeal to those concerned with the relatively low accuracy of engineering surveys, it will have little to offer to those engaged on topographical surveying even on third order work.

The author suggests that the third edition will maintain its appeal to the student, but such statements as "(In triangulation) it is not necessary to read the third angle of the triangle . . ." (page 193), and " . . . in passing under trees with low branches or through low passages the theodolite should be carried under the arm . . ." (page 138), are both dangerous and misleading to the beginner.

The inclusion of a section on the accurate methods of echo sounding is somewhat inconsistent with the accuracy of surveying methods described in the remainder of the book. Since the hydrographic surveyor has to make frequent reference to tidal movements, a short outline of the simpler tidal phenomena could well be included.

Although brief mention is made of the standard "Microptic" and "Tavistock" theodolites, it is regrettable that much of the description of surveying practice should devolve about the use of the archaic two and three-piece instruments. W.J.M.

PHYSICAL ASPECTS OF AIR PHOTOGRAPHY

By G. C. Brock, M.Sc., F.R.P.S.

(Published by Longmans, Green & Co. Ltd. Price 56s.)

For some years a very adequate literature has been available on the photogrammetric aspects of air photography, and as an effect of this, it is perhaps fashionable for the newcomer to the subject to suppose that while the geometry is all important, the photography really demands but little skill or understanding. It is fortunate that Mr. Brock, by dealing with the physical or photochemical side of the business, has done much to redress the balance.

This book is an important one for the photographer, and while the author contributes little in the way of original matter, he nevertheless succeeds admirably in setting out and analysing in one volume the results of some of the many careful investigations, which may hitherto have only appeared in the isolated papers of various scientific journals. The net outcome of the work is a thoroughly interesting and well-illustrated account of the notable advances made during the last decade in the understanding of the subject. Its fifteen chapters are written round a unifying theme—the need for the best resolution of ground detail in every photograph. The relevant properties of the photographic emulsion and problems of exposure and development are all treated from the air photographer's point of view. Photographic resolving-power and the factors which influence it are given special attention, both in the negative and printing stages. Vibration, and other movements which affect the image sharpness are discussed, and the effects of atmospheric haze on contrast and tone reproduction are explained. The author shows that infra-red, still popularly supposed to be used for haze penetration and camouflage detection, has in fact little value for these purposes, though it is useful in other ways, and he deals with the limited application of colour photography.

The book is strongly bound and includes a useful series of reproductions from air photographs, which show some comparative experiments, and many of these disprove other common fallacies.

B.N.

SOIL MECHANICS FOR ROAD ENGINEERS

(Department of Scientific and Industrial Research. Published by H.M.S.O. Price 30s.)

This book represents the fruits of the experience of the Road Research Laboratory, both in research and instruction in courses for Road Engineers which they have been running for some years. The subject matter is well arranged and written primarily for the practical road engineer. It provides a comprehensive survey of the subject, covering, therefore, a wider scope than that which normal military needs require. It includes an index of the parts of the book which apply particularly to military roads and airfield construction. As a textbook for the basic and advanced training of Royal Engineer Officers this work will be most useful for many years to come.

R.C.O.

A HANDBOOK OF WEAPON TRAINING

By Lieut.-Colonel G. E. Thornton, O.B.E.

(Gale & Polden Ltd., Aldershot. Price 15s.)

The author spent most of his army career teaching, or supervising the training of, men in the use of small arms weapons. Having retired, he can write as a "free lance," and he does not hesitate to criticize current doctrine and methods.

The book is interesting and full of accurate information about small arms weapons, as well as giving close direction to the methods of training soldiers in their use.

The Army has a pamphlet for every weapon. These pamphlets are too detailed for the N.C.O., who has difficulty in separating the "must" from the "could" in teaching—particularly in a few weeks' recruit training. The Army has also tried to absorb (not very successfully) the "method of instruction" technique. Colonel Thornton's book shows clearly how good instruction should be married to weapon training, and, for this reason alone, it should be in every unit's weapon training library.

The book does not take the place of the pamphlets, but it separates that which is important from that which it might be nice to know, and gives the reader an excellently balanced picture of the weapons it incorporates, in their separate chapters.

So often, especially in Sapper units, where there are other interests, weapon training is relegated to the category of "also ran." Any weapon training officer who has read this book intelligently cannot fail to improve the standard of training in his unit.

As well as the co-ordination of the methods of instruction with the weapon, and the thorough knowledge of the weapon itself (rifle, L.M.G., Sten, Browning pistol, grenades, mortars, are included), the author gives a lot of useful information which is not found in print elsewhere.

For instance, there are chapters on coaching with the rifle and L.M.G. Everything a good coach must know is there, and detailed examples of sight alteration are given. How many officers and N.C.Os. know the elevation table, an essential to good shooting? A chapter is given on range organization, duties at the firing point, butts, the job of coaches, and other necessities of successful range firing. There is also excellent advice on the running of a regimental rifle meeting.

The theory and application of small arms fire, the duties of a Weapon Training Officer, field firing, zeroing, miniature shooting and the construction of a miniature battle practice range, live bombing, mortar range layouts, target construction and improvization, are all dealt with.

The book is well laid out, and the diagrams are clear but an index is badly needed. The only regret is that it was not written in concise form to supplant the existing pamphlets!

Every soldier concerned with small arms training should have a copy—not excepting senior officers.

I.H.W.

TECHNICAL NOTES

THE MILITARY ENGINEER

(The Journal of the Society of American Military Engineers)

March–April 1952

"Combat Duty Pay" by General J. Lawton Collins, Chief of Staff, United States Army

An interesting article, based on a statement before the Senate Armed Services Committee, proposing the extension to front-line troops of the time-honoured principle that those whose work involves extra hazards shall receive extra pay. This principle has in the past been accepted in the military field to cover parachutists, submariners, flying personnel, and others, and the writer considers that its extension to cover front-line troops would not only remove an inequity, but would eliminate by concrete recognition the "forgotten army" feeling. Without minimizing the importance of combat duty pay, the writer believes that such recognition of these sacrifices would mean more than the pay itself to forward troops and to their dependants at home.

"Radiological Warfare Weapons," by Jack de Ment

The author, a research chemist who was present at the Bikini tests, deals briefly with these weapons, within the family of atomic weapons, known as radiological warfare (R.W.) weapons.

He adopts the broad classification of "humane" and "inhumane" for those weapons which respectively rely on penetrating radioactive radiations giving a period of grace to evacuate a contaminated area, and those which rely on enormous toxicity of radioactive agents.

Radio-active ammunition carrying microcurie, millicurie or multicurie charges, methods of loading and storage are described and illustrated. Radio-active incendiaries, smokes and mists, and radio-active "death sands," both magnetic and adhesive, are adequately described on already well-known lines.

Under "radio-active gases" the author reminds us that the application of R.W. to the normal range of conventional gases, phosgene, lewisite, mustard, adamsite and chloropicrin, by the introduction of radioactive chlorine, arsenic, nitrogen and sulphur introduces interesting new problems in defence :—

(1) Radio-active build-up in the cannister of the gas mask may eventually force the wearer to remove the mask.

(2) Normal decontamination by chemicals does not destroy the radioactive element of the gas.

(3) Blistering agents, such as mustard, by burning the skin permit entry of the radio-active-agent.

(4) A new range of poisons which would ordinarily not qualify as warfare agents may now do so in their radio-active form.

After dealing with R. W. weapons for poisoning target areas of water and recent radio-activity detection and protection equipment, the author concludes by stressing the importance of continuous research and development on this type of warfare in the interests of national defence.

May–June 1952

"Current Navy Civil Engineering Research," by Fred F. Kravath, Commander, Civil Engineering Corps, U.S. Army

The author is the Director of the Research Division of the Bureau of Yards and Docks, U.S. Navy; and describes his current research work under three programmes :—

(1) The development of new tools, equipment and techniques to meet specific needs.

(2) The development of more effective tools, equipment and techniques to replace existing.

(3) Improvement of existing satisfactory equipment to effect saving in cost, material, and maintenance.

Under (1) the author describes a 40-ton per hour, L.S.T. to shore, 22-in. belt conveyor with a speed of 33 ft. per min., fabricated in 20-ft. sections; a 30-ton per hour, ship to shore cableway with a 500-ft. span and automatic cable tensioner; a diesel pile hammer; a portable cracking plant for shipment to any part of the world where crude oil is available; and a beach stabilization unit for turning out an 11-ft. road 6 in. thick, at 17 ft. per min., to take divisional transport, using the aniline-furfural method.

Under programmes (2) and (3) the author includes lightweight generators and compressors for airborne and amphibious stages of an operation; tractors; graders; scrapers; arch-rib prefabs; and hemispherical protective shelters for severe dynamic loads (i.e., A-bomb shelters).

Besides the above, it is interesting to note that the Bureau is pursuing investigations in the passive defence phases of atomic, biological and chemical warfare.

MECHANICAL HANDLING OF STORES

(*Modern Materials Handling*, dated June, 1952.)

An extremely interesting article prepared under the direction of Major-General George A. Horkan, the Quartermaster-General to the United States Army is an account of a project of which "the ultimate goal . . . is the movement of a commodity as a unitized pallet load from the manufacturer, through military supply channels to its end use."

It describes something of the work now going on in seventeen depots in the American Zone of the Interior administered by the Quartermaster-General. In these depots there are held 2,052,000 tons of stores. Out of 33 million sq. ft. of covered storage, 21 million are occupied by stores, 3 million are vacant and 9 million are taken up by aisles and operating areas. Receipts are averaging 231,000 tons a month and issues 161,583 tons.

Ninety-nine per cent of the stores in these depots are now palletized and the following equipments are in use :—

Equipment	*Operated by Q.M. Corps*	*Supervised by Q.M. Corps*	*Total*
Industrial trucks	1,000	830	1,830
Warehouse tractors	614	261	875
Warehouse trailers	1,796	8,017	17,813
Straddle trucks	11	7	18
Warehouse cranes	26	12	38
Power sweepers	36	17	53
Heavy duty trailers	74	30	104

plus considerable amounts of conveyor, overhead equipment, etc. Pallets in use total 5 million.

Labour is the most costly item in the depots, and labour saving is the prime aim; after this comes space saving. Considerable efforts have been made to increase stacking heights and reduce widths of aisles.

Research and development are continually taking place; projects include, two-way radio control, pallet mounted conveyors, rough terrain forklift trucks, telescopic and collapsible conveyors. Much work is in hand on the standardization of pallets, containers and banding materials.

The programme is of tremendous scope and its ultimate satisfactory conclusion is in the foreseeable future.

The American general scheme as described in this article is based on the idea of complete palletization. The cost, bulk and other disadvantages of pallets appear to be accepted. This must be contrasted with the idea of parcel loading as described in the March, 1952, *R.E. Journal* and also with the development of forklift trucks fitted with squeeze clamps, both of which conceptions are aimed at reducing the number of pallets required in any general service mechanical handling scheme.

OIL ENGINE AND GAS TURBINE DEVELOPMENTS

(*The Oil Engine and Gas Turbine*, dated August, 1952)

A review is given of developments and applications of oil engines and gas turbines. In the Editorial, attention is drawn to the fact that development of oil engines is proceeding rapidly, particularly in the smaller sizes. Civilian, as distinct from military, needs have a call for ever-increasing power outputs from engines of limited bulk. A fundamental factor is the choice of cycle and it is noted that much more attention is now being paid to the loop scavenge engine.

The development of pressure charging techniques has an important bearing on power/weight ratio. Variable compression blowers and change-speed gears in blower drives are recently-introduced developments, which will enable the engine output characteristics to be more closely related to the particular task. Thought is being given to having a compressor which can be used at will in order to provide additional power at peak demands. Hitherto most turbo chargers have provided air to the cylinder at pressures up to about 5 p.s.i., but equipment now listed can provide 10 or even 20 p.s.i. In conjunction with higher blower pressures the use of charge cooler for cooling the ingoing air is making headway, particularly in static applications where moderate temperatures are available.

Although there has long been a military requirement for skid mounted sets in which prime movers and driven units are supplied coupled together on a fabricated steel base plate, it is only comparatively recently that any considerable prominence has been given to this feature for civilian requirements. Engines of up to 1,500 b.h.p. can now be supplied mounted on base plates with the driven unit. The saving of time and labour in installation is enormous.

The introduction of "baby" horizontal engines running at speeds up to 1,500 r.p.m. and which of course have a marked reduction in height compared with their vertical equivalents, is an interesting feature.

There has been appreciable progress in cooling, and closed circuit systems are now almost universal, trouble with deposits becoming a rarity. Direct (or air) cooling is becoming more widely used for static plant, and engines up to 175 b.h.p. are now regularly cooled by fan impelled air streams. Much more use is being made of rejected heat from oil engines by means of waste heat boilers and over-all thermal efficiencies of dual function plant often exceeds 50 per cent.

In the lubrication field much more attention is being paid to oil cooling, even in mobile applications. Heavy duty detergent oils are being much more widely employed, both for high-speed engines and for the larger stationary engines.

The ability to use various fuels is an important modern design development of certain engines. Fuels other than liquid ones, or combinations of fuels can be employed. New starting methods have of recent years given the user the additional choice of manual effort multiplied by hydraulic-pneumatic means or of cartridge starting. For starting in cold conditions a more recent development is the use of ether capsules in the air streams. All these methods are of considerable interest to the military engineer.

The development and application of the gas turbine is proceeding so rapidly and over so wide a field that the oil engine has had to restrict the developments surveyed to those which, on the whole, affect heavy industry, and which do not all directly, therefore, affect the military engineer. Some details are given, however, of a U.S. coal-burning, gas-turbine locomotive plant and of a coal-burning, gas turbine locomotive recently ordered by the Ministry of Fuel and Power. There is mention also of the Shell tanker *Auris*, which recently crossed the Atlantic operated entirely on a B.T.H. gas turbine.

REFRIGERATION FROM EXHAUST GAS

(*The Oil Engine and Gas Turbine*, dated July, 1952)

An article describes a development in the U.S.A. where the heat from the exhaust gases of a diesel engine is used to operate a refrigerator working on the absorption cycle. The cooling thus produced is used indirectly to cool the intake air to the diesel engine.

This principle may have a possible application to installations in the tropics where, for instance, a generating set with a normal rating of 300 K.W. would have to be derated to 245 K.W. It could also be applied to underground headquarters where the heat from generating sets could provide the refrigeration for air conditioning.

SAWDUST AS FUEL

(*The Oil Engine and Gas Turbine*, dated August, 1952.)

An article entitled "Experiments with a Sawdust-burning Turbine" describes an experimental gas-turbine using sawdust fuel being tried out by the Oregon Forest Products Laboratory (U.S.A.).

Whilst the use of such a turbine by the Forestry Squadrons lies in the somewhat remote future, the principle of the furnace used may well be applied to the generation of steam power where sawdust is a by-product.

The furnace consists of a vertical cylinder with a mild steel grate through the centre of which the sawdust is fed vertically upwards by an "Archimedes screw" forming a conical heap on the grate. Air supply is by forced draft and controlled by dampers so that part of the air is supplied under the grate and part over the top of the sawdust heap. It is claimed that the highest heat release, based on grate area, is three times that achieved in most sawmill installations using waste wood fuel. On the furnace volume basis, the heat release is said to be about fifteen times that achieved in wood-burning steam boilers.

TRANSISTORS

(*The Engineering Journal of Canada* dated July, 1952.)

In the field of electronics we have become accustomed to discoveries and developments which, a few decades ago, would have been considered miraculous, if not indeed sheer witchcraft. The invention of the transistor is claimed to be the greatest step forward since the vacuum tube.

Investigation of the properties of semi-conductors, such as silicon and germanium, led to the discovery of transistor action. The distribution of excess valence electrons is changed by the application of electrical potential and, by using two contacts in close proximity, amplification is obtained through modulation of the conductivity of the semi-conductor.

Basically, the transistor is an amplifier and can therefore be used as an oscillator or modulator; it can also act as a demodulator or detector. It is more reliable, more durable and, in some applications, vastly more efficient than the vacuum tube. It is much smaller and its power input requirement is of the order of a few milliwatts.

Its development is likely to revolutionize the design of radio sets, radar and guided missiles. Even smaller and more efficient hearing aids will compete with a "vest-pocket" public address system, and the portable radio of the future may be a "six flea-power" wrist-watch model.

THE KOOTENAY LAKE SPAN

(*The Engineering Journal of Canada* dated August, 1952.)

An overhead transmission line spans the Kootenay Lake in British Columbia. The arresting feature of this achievement is that the clear span is just over two miles, and is claimed to be 1,000 yds. more than that of any span previously constructed. The difference in ground level at the terminal towers is some 1,200 feet and the specified minimum clearance of the cables above high water 120 ft. Power requirements for the three-phase supply are 170,000 v. : 72,000 kva.

The factors affecting the design are clearly set out in a short factual article and a brief summary of the economic considerations leading to the adoption of the scheme is also of interest.

RECENT DEVELOPMENTS IN THE USE OF CONCRETE AND REINFORCED CONCRETE

(*The Engineering Journal of Canada*, dated August, 1952.)

Concrete now comprises a range of materials with widely-differing properties. Compressive strength may vary from 500 lb./sq. in. to upwards of 12,000 lb./sq. in., and density from as little as 30 lb./cu. ft. to 270 lb./cu. ft.

Special cements have been developed for a variety of purposes. High alumina cement gives great early strength; expansive cements have been used in arch-work and for under-pinning; blast furnace slag cement is but one type giving resistance to chemical action.

The dead weight of structures depends largely upon the aggregate used: it can be reduced by grading, consolidation by vibration and the use of heat and pressure.

Admixtures include air-entraining agents giving improved durability; gas-producing or foaming agents for light-weight or "gas" concrete; and materials for waterproofing, damp-proofing and the counteraction of chemical effect.

New methods of transporting and consolidation have been developed; high-tensile reinforcement is under trial; pre-cast concrete elements are now extensively used; pre-stressed concrete is used to save steel.

One of the most important developments in design is the use of assemblies of thin plates and cylindrical shells, readily built in reinforced concrete and impossible in any other structural material.

This paper is an admirable summary of present knowledge and practice.

It is illustrated by an excellent series of photographs and includes an impressive bibliography.

(*Civil Engineering and Public Works Review*, dated August, 1952)

An article describes equipment for investigating and measuring the beneficial effect of vibratory compaction on the strength of concrete.

These days, owing to shortages, it is more essential than ever that steel is used economically in both reinforced and prestressed concrete. One of the most effective ways to do this is to improve the quality of the concrete itself. The use of vibration is an important factor in producing good concrete, as not only is a harsh mix made more workable but, by suitable compacting, the density is increased, the percentage of air voids decreased and thus the loss of strength due to voids is kept to a minimum.

There is still a lot of research work to be carried out on vibration and an instrument has been developed for this purpose. Basically it consists of a table top, mounted on two pairs of cantilever springs, which is vibrated electrically. The use of springs eliminates bearings, lubrication and all wearing surfaces.

During experiments a suitable vibration meter is attached to the table, whilst the sample under test is viewed by a stroboscope which is arranged so that its flashes are synchronized with the vibration. Thus the sample appears to stand still and can easily be observed.

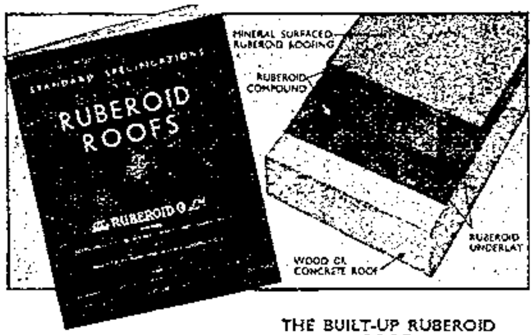
(*Civil Engineering*, dated September and October, 1952)

A great part of the improvement in the quality of concrete in the past decade has been due to the scientific design of the mix, and to the placing of more dry concrete by mechanical means. In an important article D. A. Stewart suggests further advance in mix design, so that the reliable strength of concrete may be pushed a little higher still.

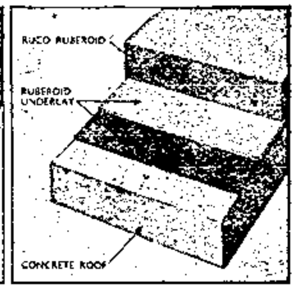
The strength of concrete lies in the coarse aggregate, not in the cement-and-sand filler, and the more closely the stones can be packed the stronger the concrete will be. As less of the filler will be required, the mix will also be cheaper. In order to discover the best gradings of aggregate to achieve this close packing, experiments have been carried out with the packing of spheres, and partly as a result of these, the best size of particle to fill the voids between the larger pieces of coarse aggregate has been determined. The grading advocated is not the "continuous" grading in general use, but a "gap-grading," to suit the best possible packing of the larger stones.

The concrete produced is likely to be unworkable by manual methods, and vibration will be essential for its placing. This, in turn, calls for some new thoughts on the arrangement of reinforcement, but the cheaper concrete, less liable to shrinkage and creep, together with the earlier removal of the formwork, should make the extra trouble well worth while.

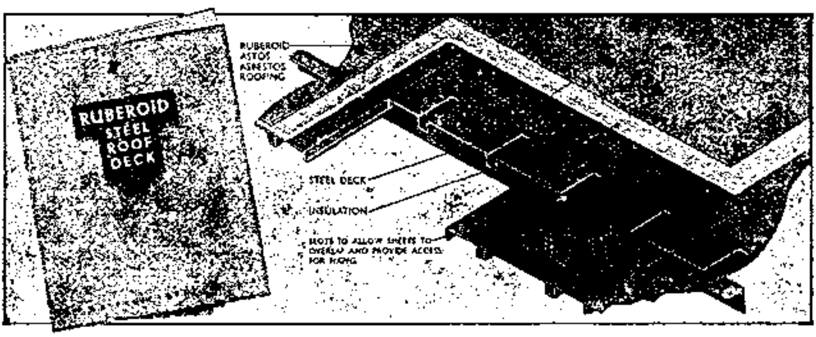
RUBEROID ROOFING SPECIFICATIONS



THE BUILT-UP RUBEROID ROOF



THE RUCO-RUBEROID ROOF



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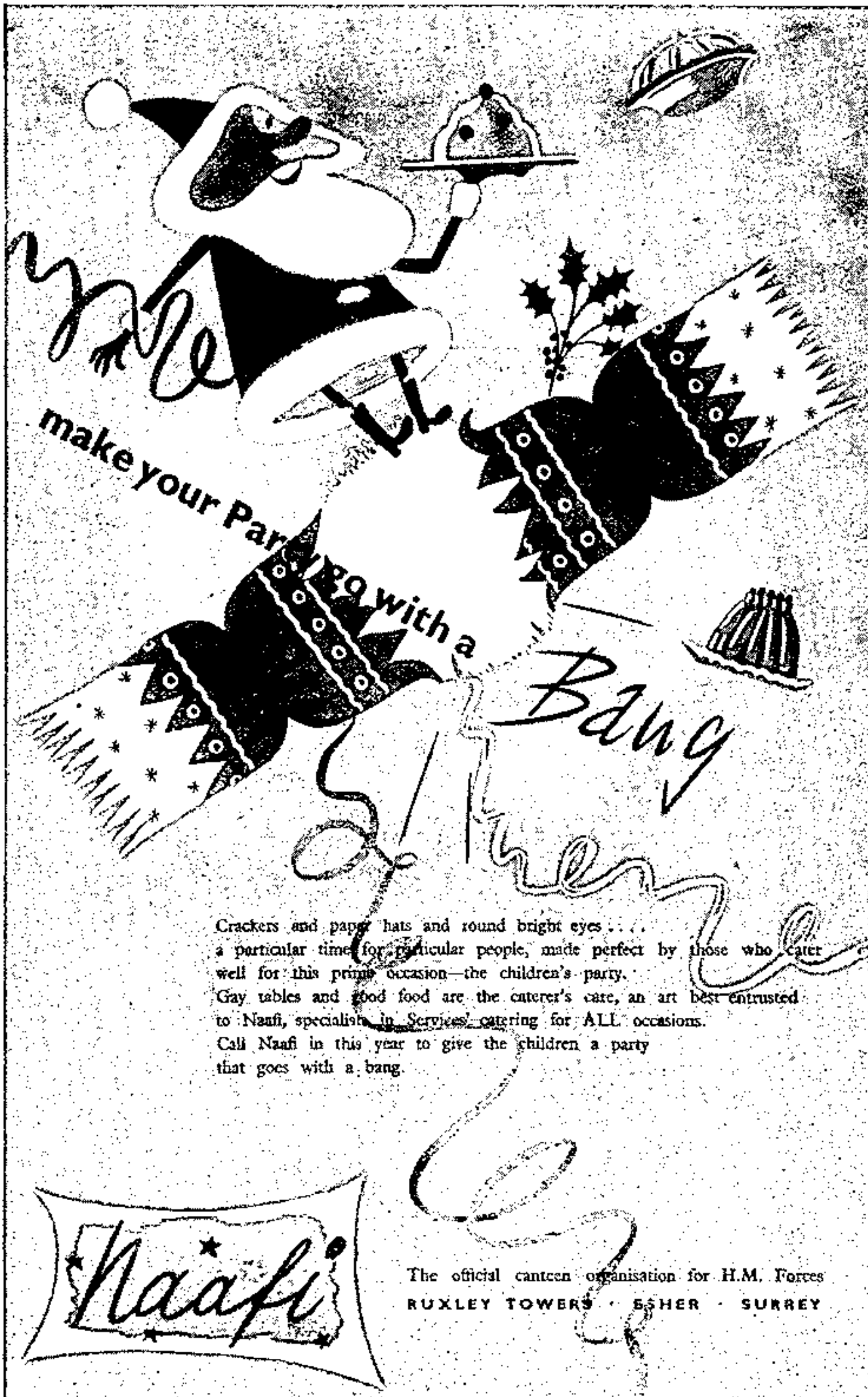
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